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Raimo Heikkilä, Hanna Heikkilä, Aleksei Polevoi & Evgeni Yakovlev (eds.)

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OULU 2000

NORTH OSTROBOTHNIA REGIONAL ENVIRONMENT CENTRE

ISBN 952-11-0700-6
ISSN 1238-8610

Cover photo: Raimo Heikkilä (Primeval forests in the proposed Kalevala National Park)
Layout: Marjut Hyvärinen
Multiprint
Oulu 2000

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Preface

Raimo Heikkilä

This publication has been compiled as a result of studies made in northern Russian Karelia along the boundary of Finland in the EU LIFE project "Protection of old-growth forests in Kuusamo area (B4-3200/96/543)". In eastern Finland there are numerous areas of old–growth forest areas hosting a special fauna and flora containing a number of threatende animal, plant and mushroom species.

In the province of Kainuu and southernmost Kuusamo the Finnish–Russian border has been in the same place since 1595. On different sides of the boundary there are big differences in the land use history. In Finland slash and burn cultivation, tar extraction and selective loggings have in different times influenced the nature, and completely pristine forests are extremely rare and small in area. From 1950, clearcuts have taken over most of the forests. Due to the history of land use on the Finnish side, the forests have been greatly fragmented, and the nature reserves in the middle and northern boreal zones to the south of the Polar Circle are mostly very small in area.

On the Russian side forests have been utilized intensively only nearby villages. Along the boundary there are still hundreds of thousands of hectares of pristine forests forming a diverse mosaic with mires and watercourses. These forests still contain a very high biodiversity, and they serve as sources for the decreased or extinct populations of old–growth forest species in the small sink fragments on the Finnish side.

There have been established significant nature reserves, Kostamus strict Nature Reserve and Paanajärvi National Park. In addition, several proposals for establishing nature reserves in Kostamus and Kalevala districts have been made. There has been a lot of argument about the matter, and therefore additional knowledge as a basis for the discussion has been urgently needed. The aim of this publication is to serve as a tool to protect the biodiversity in the boreal forests both on Russian and Finnish side of the boundary.

Mr. Martti Salo has prepared the figures of this publication in their final form. Mr. Grigori Sokolov and Mr. Pavel Shevelin have translated parts of the text into English, and Mr. Nick Bamber has revised the English language. I express our warmest gratitude to them.

Biodiversity of vascular plant, lichen and hepatic flora of the old growth forests in the Green belt of Russian Karelia

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Introduction

The question of preserving the last remaining areas of old forest in the west taiga zone of Russia has come very much to the fore over the last five years. Large enough areas of more or less undisturbed forests can be found on the White Sea – Baltic Sea watershed in the zone bordering Karelia and Finland and in the adjacent areas of Karelia, Archangelsk and Vologda. These areas are situated in the most inaccessible parts of the region. They display a natural mosaic of old growth forests, paludified forests, mires, lakes and watercourses. The felling of old growth forests and other forestry activities have together had a detrimental effect on a large number of organisms occurring in these areas. The surviving forests play an important role in the conservation of typical taiga biota. At the present moment in time the vast intact areas of untouched forest situated in north–western Russian Karelia are threatened by the impending logging activities of a number of Russian and foreign timber companies.

The quality of ecosystems and character of anthropogenic changes affecting them can be assessed using indicator species. Lichens, polypores, bryophytes, saproxylic invertebrates and dendrophylous (hole–nesting) birds are generally considered as good indicators of old growth forests (Ehnström & Walden 1986, Virkkala 1987, Söderström 1988, Esseen et al. 1992, Angelstam & Mikusinski 1994, Haila et al. 1994, Kaila et al. 1994, Siitonen 1994, Kuusinen et al. 1995, Kotiranta & Niemelä 1996). Lichens and mosses, especially hepatics, are the commonly accepted indicators of such human activities as logging. An assessment of the most critical factors for the long–term survival of threatened species in Sweden shows that clear felling is harmful to more than half of those species (Berg et al. 1994, Gustafsson 1996).

The general aim of the present study was to analyse the biodiversity of the flora in the vast areas of presently unprotected old growth forest situated along the Russian–Finnish boundary from Lake Tuulijärvi to Lake Paanajärvi in northern Karelia. The most valuable areas were delimited and their conservation value estimated. Special attention was paid to rare and threatened species listed in the Red Data Books of Russia and Karelia (Borodin et al. 1988, Ivanter & Kuznetsov 1995).

Field work was conducted in July and August 1998. Use was also made of unpublished data collected by the same researchers during 1996–1997 from the areas in question.

The flora and species composition of vascular plants, lichens and hepatics of old growth forests were analysed and possible indicator species were investigated. In particular, the distribution of rare, threatened or otherwise remarkable species was studied. Areas valuable in terms of protection, tourism, recreation and education were selected.

Methods

Old growth forests were the main target of the study. Attention was also paid to other key biotopes displaying a high degree of biological diversity. Such biotopes include pre–mature forests containing a large amount of dead wood, herb–rich forests, wet forests, forest edges, forested ravines (especially those with rocky slopes), lake shorelines, rivers and brooks, transitional and spring mires, bedrock outcrops (especially cliffs) and fells.

The system and nomenclature of vascular plants follows Cherepanov (1995). The names of hepatics are given according to Konstantinova et al. (1992) and Konstantinova & Vasilyev (1993). The genus *Lophozia* was interpreted according to Schljakov (1980).

Some 2 000 vascular plant specimens, 300 specimens of hepatics and 150 specimens of lichens were collected. The material is now stored in the herbaria PTZ (Forest Research Institute, Petrozavodsk), PZV (Petrozavodsk State University) and KPABG (Polar–Alpine Botanical Garden, Kirovsk).

Study area

The study areas were selected according to proposals of establishing protected areas in the border zone of Russian Karelia and Finland (Belousova et al. 1992, Sazonov & Kravchenko 1996) and recent information on the potentially valuable forest areas of Fennoscandia and northern Russia (Angelstam & Majewski 1996). A map of the most important forest areas in Russian Karelia compiled by the Russian Biodiversity Conservation Centre and Greenpeace Russia (1997) was used to identify areas of old growth forests. Latest information concerning features of the old growth forests of the border zone of Russian Karelia (Pyykkö 1996, Ovaskainen 1998) was also exploited. The main focus was directed towards the vast areas of unfragmented forest located in the proposed national park (PNP) Kalevala and areas around the Paanajärvi National Park. Some old growth forest fragments and other possible biotopes of rare and threatened species occurring along the roads from Kostamus to Pääjärvi, Paanajärvi and Kalevala were also briefly visited (Fig. 1).

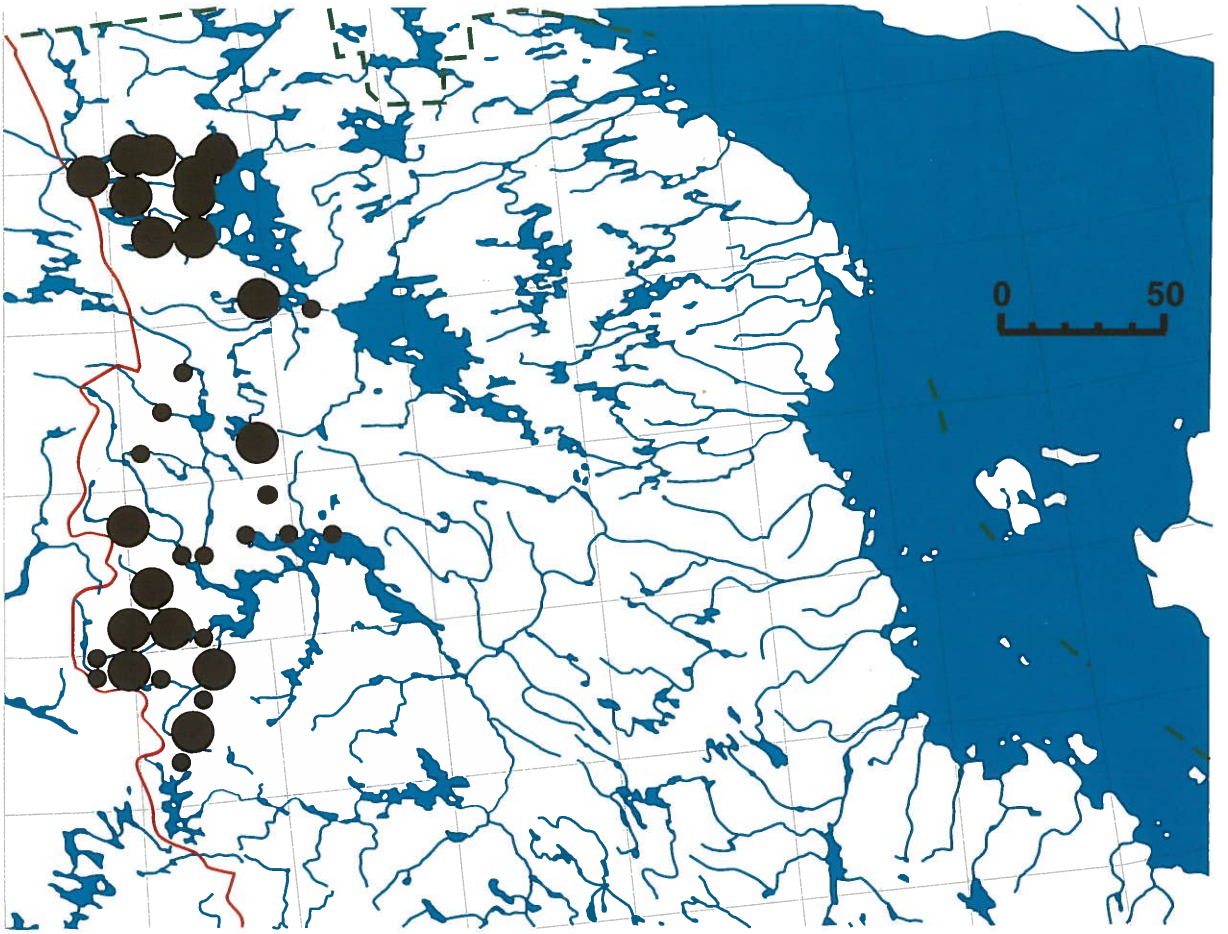

Fig. 1. Surveyed areas in north-west Karelia

● *Long term observation of large territory*

● *Short trips*

The following localities have been studied.

Karelia pomorica occidentalis

1) Kostamus: 10 km north of the town of Kostamus.
2) Latvajärvi: the area around Lake Latvajärvi extending westward to Vasen vaara, south–west to Kivijärvi, east to Pahkominvaara, north–west to Lake Lapukkajärvi, and north to the River Kaba.
3) Kormila: the area around Lake Kormilanjärvi, extending north up to Lake Keynäsjärvi, south–east as far as Tollonjoki village, 10 km north–eastwards and west to Lake Lumbasjärvi.
4) Kaunis: the area around Lake Kaunisjärvi, extending north–east to Lake Vit sajärvi, south–east to Lake Piirtojärvi and 5 km towards the west.
5) Venehjärvi: an area around Venehjärvi village of approx. 4–5 km radius.
6) Haukilampi: the area between the River Kurtshma and Lake Haukilampi.
7) Kokkojärvi: the area east and south–east of Lake Kokkojärvi.

Regio Kuusamoensis

1) Leppikuru: the environs of the frontier post north as far as the shore of Lake Paanajärvi.
2) Lohilampi: the vicinity of Lake Lohilampi and the Lohioja brook basin.
3) Mäntyjoki: the Mäntyjoki river basin extending five kilometres upstream and the shores of Lake Paanajärvi one kilometre to both east and west of the river mouth.
4) Selkäjoki: the Selkäjoki river basin.
5) Ukontunturi: the environs of Ukontunturi Fell.

Karelia keretina

1) Ohtajärvi: the area between Lake Ohtajärvi and Lake Kalliojärvi.
2) Tuhka: the area between the settlement of Pääjärvi and the River Pontsalonjoki, and eastwards as far as Sohjana village.
3) Tavajoki: the area around the bridge across the River Tavajoki.
4) Kivakka: the locality of Kivakka Fell (mainly western slopes).
5) Oulanka: the area approx. 3 km north and 3 km downstream from the source of the River Oulanka.
6) Siltajoki: the area around the bridge crossing the River Oulanka.
7) Vartiolampi: the area between the abandoned village and Kivakkakoski Ra pids, also extending approx. 2 km to the north and north–east.
8) Leppijoki: the Leppijoki river basin and an area of several small unnamed lakes towards the north–east.
9) Hankalampi: the surroundings of Lake Hankalampi and an unnamed lake towards the west.
10) Päänuorunen: the surroundings of Päänuorunen Fell, extending north and north–east as far as Lake Tsipringa.

Results

Vascular plants

Local florulas

Existing knowledge of the vascular plant flora of Russian Karelia is far from complete. There are only few publications concerning the flora of the vast area stretching from Lake Tuulijärvi to Lake Paanajärvi. One important publication deals with the flora of the entire area from Kostamus to Paanajärvi (Wainio 1878). Some rather fragmentary data on the Ohtanjärvi area was published by Mannerkorpi (1944) and Erkamo (1947), and on the Tuulijärvi area by Jalas (1948).

Paanajärvi, however, is one of the most explored regions in Karelia. There are plenty of relevant publications, as well as archive and herbarium sources for this area. Important information has been published by Auer (1943) on the Paanajärvi lake basin and Söyrinki (1956) concerning the Oulanka river basin.

Almost all old records (made before World War II) from the study area are taken into account in the Atlas of Hulten (1971).

Recent publications provide less than comprehensive information on the vascular plants of Nuorunen Fell and its surroundings (Kravchenko 1995), Tuulijärvi PNP (Kravchenko et al. 1997) and Kostamus Nature Reserve (Kravchenko 1997). General information on the flora of the proposed Kalevala National Park has been

published (Gromtsev 1998) while data concerning the surveyed areas around the park were recently published by Finnish NGOs (Pyykkö 1996, Ovaskainen 1998). However, the data relating to vascular plants is by no means exhaustive.

The composition of flora in the Kalevala and Paanajärvi areas is given in Appendix 1 and Appendix 2, respectively.

Indicator species

Vascular plants are considered to be less important indicators of old growth forests than lichens and mosses. For example, Esseen et al. (1992) stress that in Fennoscandia only a few vascular plants appear to be exclusively confined to very old forests and threatened by clear felling. The majority of them persist in the small patches which have survived felling. These include woody ravines, wet forests, forests growing by the sides of brooks, forests on steep slopes, etc. However, some forest herbs, especially orchids such as *Calypso bulbosa, Goodyera repens* and *Listera cordata,* die out completely in areas affected by clear felling (Ingelög et al. 1987, Esseen et al. 1992).

At present, a large number of vascular plants are considered to be threatened or detrimentally affected by forestry. For example, in Sweden common forestry practice has resulted in the decline of 73 vascular plant species (Ingelög et al. 1987). Among species of threatened plants in Finland some 14 % are detrimentally affected by forestry practice (Rassi & Väisänen 1987). According to the Red Data Book of Russia (Borodin et al. 1988) felling is the cause of decline in about 10 % of all vascular plant species while almost 17 % of the vascular plants listed in the Red Data Book of Karelia (Ivanter & Kuznetsov 1995) are considered to be vulnerable to felling activities.

During recent years a number of extensive lists of vascular plants which could be used as indicator species in Finland have been published (Siitonen 1996, Kytövuori 1998, Turunen 1998).

Discussion concerning the use of vascular plant species as indicators of old growth forest in Karelia has been pursued only very recently. This is in spite of Zinzerling's observations, made as far back as 1925, that the majority of the tall herbs of eastern origin are affected by clear felling, with the species *Diplazium sibiricum, Actaea erythrocarpa, Ranunculus borealis, Rubus humulifolius* and *Crepis sibirica* specifically referred to.

A study into the effects of clear felling on certain boreal plant communities was recently conducted in untouched areas of Vodlajärvi National Park and in the northernmost parts of the Vologda region close to areas of clear–fell. Various degrees of detrimental impact of such felling was recorded on 40–50 % of the vascular plant species occurring. A significant proportion of affected species was made up of typical taiga sciophilous plants. For example, hemerophoby is especially widespread among pteridophytes, orchids, and tall herbs and grasses (Kravchenko 1998).

The role of vascular plants as indicators of the consequences of logging has also been recently studied for the south–boreal zone near the Karelian village of Matrosy (Kravchenko et al. 1998). In general, areas of paludified forests and small groves left in place after clear felling had been carried out contained sufficient amounts of indicator species. In areas of south–boreal zone, up to the beginning of the 1980s forest affected by logging and retaining numerous untouched patches (in some cases up to one third of a given territory) vascular plants function as quite reliable indicators of old growth forest. There are between fifteen and twenty–five indicator species for dry (xeric, mesic–xeric) forest types. In herb–rich and wet forests there are clearly defined groups containing dozens of indicator species. Our

opinion is that in the mid–boreal zone a wide range of vascular plants may be used as indicators for the identification of old growth forest and the selection of stands most valuable from the conservation perspective.

In northern boreal forests the situation is different. In the circumboreal zone an extensive understorey of dwarf shrubs, herbs, sedges and grasses is commonly encountered. In dry sites the field layer of vascular plants is made up of no more than 10–15 species in total (Tonteri 1994). Consequently, only a few vascular plant species can be considered as indicators of old growth forest in dry sites. As usual the number of ferns and herbs is fairly low in such dry forests but may be quite prolific in mesic and especially in wet forests. Herb–rich forests as well as various types of wet forests should, therefore, provide more extensive lists of potential indicator species.

In all, a total of forty–six species have been proposed as indicators for the areas of Kalevala and Paanajärvi (Table 1). We have taken into account only those species recorded during the present study. Eight of these apply to dry forest types (xeric, sub–xeric and mesic–xeric), twenty–eight to various types of wet forest and ten to both dry and wet forests.

Rare, threatened and otherwise remarkable species

Information has been collated concerning all those species listed in the Red Data Books of Russia – RBR (Borodin et al. 1988) and Karelia – RBK (Ivanter & Kuznetsov 1995) which were found in the areas surveyed. The categories of protected species are as follows: V – vulnerable; R – rare; I – indeterminate or in need of monitoring. By the geographical term 'northern Karelia' we understand those territories situated inside the borders of the northern taiga subzone (extending southwards as far as Lake Segezhskoe at about 63° N), in accordance with Yakovlev & Voronova (1959). The distribution of species in Karelia is given according to Hultén (1971), Ramenskaya (1983), Kravchenko and Kuznetsov (1995), a number of special publications, and our own recent unpublished data. The biogeographical provinces of Karelia (Mela and Cajander 1906) referred to, are as follows: Kl – *Karelia ladogensis*, Kol – *Karelia olonetsensis*, Kp – *Karelia pudogensis*, Kb – *Karelia borealis*, Kon – *Karelia onegensis*, Kton – *Karelia transonegensis*, Kpoc – *Karelia pomorica occidentalis*, Kpor – *Karelia pomorica orientalis*, Ks – *Regio kuusamoënsis*, Kk – *Karelia keretina*.

In all, thirty-four species listed in Red Data Books were found at 130 different locations. The majority of sites in Paanajärvi National Park were already known. The distribution of the most interesting species in Karelia is mapped (Figs. 2–21).

Annotated list of protected and rare species found in areas surveyed

Protected species

Woodsia alpina (Bolt.) S. F. Gray. RBK – R. Rare species distributed very sparsely throughout the whole of Karelia and found at less than twenty sites mainly in Kl and Ks, as well as in Kon and Kpoc. Ks. 3: Mäntykoski, on calcareous cliffs; the shores of Lake Paanajärvi approx. 1 km west from the mouth of the River Mäntyjoki, on calcareous outcrops. 4: Selkäkoski, on calcareous cliffs.

Botrychium lanceolatum (S.G.Gmel.) Ångstr. RBK – I. Rare species distributed very sparsely throughout Karelia (mainly in Kl and Kpoc) and found at less than twenty–five localities. Kpoc. 2: Vasenvaara, on dry meadow; Pahkominvaara, on dry trampled meadow. Kk. 1: on dry meadow. 2: Sohjana village, on dry meadow on outcrops of bedrock.

Diphasiastrum alpinum (L.) Holub. RBK – I. Rare species, the Karelian distribution of which is mainly restricted to Ks as well as to two sites in Kpoc and two in Kk. Ks. 5: Ukontunturi Fell; Possosiro Fell. Kk. 10: Kivakka Fell; Päänuorunen Fell. – All localities are situated in the oroboreal zone.

Isoëtes setacea Durieu. RBR – V, RBK – I. Very common in Karelia, except in the two northernmost provinces Ks and Kk and three easternmost provinces Kpor, Kton, Kp, where it has been found at only a few sites. Kpoc. Very common through the whole area. Kk. 1: on the southern shore of Lake Ohtajärvi on the sandy–silt bottom. 3: on the western shore of Lake Karnisjärvi.

Isoëtes lacustris L. RBR – V; RBK – I. Rather common in Karelia except in the two northernmost provinces Ks and Kk and three eastern provinces Kpor, Kton, Kp, where it has been found at only a few localities. Kpoc. 2: Lake Kivijärvi, south–eastern shore, on gravel bottom; Lake Lapukkajärvi, eastern shore. 4: Lake Vitsajärvi, south–eastern shore; Lake Kaunisjärvi, north–western shore; Lake Piirtojärvi, western shore, on sandy–gravel bottom.

Agrostis clavata Trin. RBK – R. Very rare species recorded in Karelia at only two localities in Kk to the north of Lake Pääjärvi (Widen 1971). Kpoc. 4: 0,5 km south from Lake Vitsajärvi, wet pine forest; 3 km from the bridge across the River Vuokinjoki, wet pine forest.

Eriophorum brachyantherum Trautv. et. Mey. RBK – I. Very rare species recorded mainly in Ks and at three localities in Kl and Kon and one in Kk. Ks. 1: approx. 0,5 km south from the frontier post, spruce swamp. 2: brook–side spruce swamp approx. 2 km upstream from the mouth of Lohioja brook. 3: riverside spuce swamp approx. 2 km upstream from the mouth of the River Mäntyjoki.

Carex adelostoma V. Krecz. RBK – R. Rare species known in Karelia from less than ten sites (Ks, Kk, Kpoc). Ks. 1: wet mixed forest on the shores of Lake Paanajärvi. 5: northern slope of Possosiro Fell approx. 250 m above sea level, spruce swamp. Kk. 4: western slope approx. 300 m above sea level, wet brook–side spruce forest.

Carex media R. Br. RBK – R. Rare species distributed mainly in Ks, as well as in few localities in southern Karelia (Kl, Kon, Kton, Kpoc) where it has been found at less than ten sites. Kk and Ks. In many localities (App. 2).

Carex livida (Wahlenb.) Wild. RBR – R; RBK – I. Rather common throughout Karelia, except in the three eastern provinces Kpor, Kton, Kp, where it has been found at only one site. Typical species of aapa mires. Kpoc. 5. Venehjärvi. Kk. 1: south–eastern shore of Lake Ohtajärvi, aapa mire.

Calypso bulbosa (L.) Oakes. RBR – R; RBK – R. Rare species of sparse distribution, most common in Ks and Kk, also in Kl, Kol, Kp, Kton (less than fifteen finds for the last–mentioned four provinces), a total of approx. thirty–five sites in the whole of Karelia. Ks. northern shore of Lake Paanajärvi near to the source of the River Oulanka, Vaccinium – Myrtillus pine forest on calcareous soils. Kk. 6: 3 km northwards from the mouth of the River Siltajoki, Geranium – Myrtillus spruce forest by a brook.

Schoenus ferrugineus L. RBK – 3. Very rare species found at only a few localities in Kl, Kon, Ks (five in all) and some in Kpoc (Lehta area). Ks. 2.: aapa mire at the source of Lohioja brook.

Cypripedium calceolus L. RBR – R; RBK – V. Rather rare, sparsely distributed species chiefly occurring in Kon and Ks and less commonly in Kl, Kol, Kp, Kton, Kpoc. Data on the most recent finds in Paanajärvi National Park were reported by Systra & Huttunen (1998). Kk. 5.: left bank of the River Oulanka, approx. 1 km downstream from Niskakoski Rapids, spruce swamp.

Dactylorhiza cruenta (O.F.Muell.) Soo. RBK – R. Rare species reported in Kl, Kol, Kon, Kton, Kpoc, in all less than ten localities. Kpoc. 2: approx. 0,5 km south–west from Lake Latvajärvi, transitional mire; 4 km north–west of Lake Latvajärvi, transitional mire.

Dactylorhiza traunsteineri (Saut.) Soo s.l. RBR – R; RBK – I. Rather common species throughout Karelia known from all provinces. Kpoc. 2: approx. 0,5 km south–west of Lake Latvajärvi, transitional mire; approx. 2 km south–west of Lake Latvajärvi, transitional mire; approx. 7 km north–west of Lake Latvajärvi, aapa mire; approx. 10 km north of Lake Latvajärvi, transitional mire. Ks. 1: aapa mire approx. 1 km south–east of the frontier post. Kk. 1: south–eastern shore of Lake Ohtajärvi, aapa mire. 3: approx. 2 km upstream from the bridge, transitional mire.

Moehringia lateriflora (L.) Fenzl. RBK – R. Rare species of common occurrence only on the banks of the River Vodla (Kton). Recorded at less than ten sites in Kol, Kon, Kpoc, Kpor, Kk altogether (without Kton). Kpoc. 50 km east of Kalevala, River Kepa, riverside bushes, as well as on steep areas of moraine running along the roadside.

Stellaria calycantha (Ledeb.) Bong. RBK – R. Rare species found in Karelia mainly in Ks as well as at a few sites in Kk. Kpoc. 2: north–western shore of Lake Latvajärvi, spring fen; eastern shore of Lake Latvajärvi, secondary wet birch forest; 4 km west of Lake Latvajärvi, brook–side spruce forest; Haapovara, spruce swamp; south–western shore of Lake Kivijärvi, spring fen. Korm. 3: approx. 9 km south–west of Lake Kormilanjärvi, brook–side. 4: approx. 2 km west from Lake Kaunisjärvi, brook–side. 6: approx. 4 km north–west of Haukilampi pond, brook–side spruce swamp. Ks. 2: approx. 1 km upstream from the mouth of Lohioja brook, brook–side fen. 3: approx. 2 km upstream from the mouth of the River Mäntyjoki, riverside spruce swamp. Kk. 1: approx. 0,5 km north–east from Lake Kalliojärvi, brook–side. 2: River Kuhka approx. 0,5 km downstream from the bridge, riverside spruce swamp.

Steris alpina (L.) Rafin. RBK – R. Rare species discovered at less than five sites in southern Karelia (mostly in Kl, but also in Kton). In northern Karelia it has been recorded in Kpoc, Kpor, Kk, Kk. Kk. 3: River Tavajoki approx. 2 km upstream from the bridge, on outcrops of bedrock.

Batrachium eradicatum (Laest.) Fries. RBK – I. Very rare species found in less than ten localities in Kl, Kon, Ks and Kk. Ks. 3: 2 km upstream from the mouth of the River Mäntyjoki, on gravel bottom.

Arabis alpina L. RBK – V. Very rare species recorded in Karelia at only three localities north of Lake Paanajärvi. Ks. 3: 3 km upstream from the mouth of the River Mäntyjoki, riverside fen.

Potentilla crantzii (Crantz) G. Beck ex Fritsch. RBK – V. Very rare species known in Karelia from only three localities in Kl and two in Kk. Kpoc. 7: Kumi Rapids, on outcrops of bedrock; Ks 3: River Tavajoki approx. 2 km upstream from the bridge, on outcrops of bedrock.

Astragalus frigidus (L.) A. Fray. RBK – R. Rare species restricted to Ks and Kk along the Paanajärvi – Oulanka watercourse. Ks. 2: shore of Lake Paanajärvi. 3: 0,5 km upstream from the mouth of the River Mäntyjoki, riverside. Kk. 5: left bank of the River Oulanka approx. 0,5 km downstream from Niskakoski Rapids, riverbank. 6 and 7: common along the banks of the River Oulanka.

Astragalus subpolaris Boriss. et Schischk. RBK – R. Rare species, the Karelian distribution of which is mainly restricted to Ks. There are only a few localities (approx. five) in the whole of southern Karelia (Kl, Kol, Kb, Kon) and approx. five in

Kpoc and Kk. Ks. 1: right bank at the mouth of the River Oulankajoki; roadside near the frontier post. 2: shore of Lake Paanajärvi. 3: sandy beech near the mouth of the River Mäntyjoki. Kk. 5: left bank of the River Oulanka approx. 0,5 km downstream from Niskakoski Rapids, riverbank. 6: left bank of the River Oulanka close to the bridge.

Oxytropis sordida (Willd.) Pers. RBK – R. Rare species of sparse distribution in Karelia and often connected with end moraines and eskers (Jalas 1950). Only few localities (approx. ten) in southern Karelia (Kl, Kol, Kon), approx. ten in Kpoc and a few in Kk. Ks. 1: right bank at the mouth of the River Oulankajoki. 2: shore of Lake Paanajärvi 3: sandy beach near the mouth of the River Mäntyjoki. Kk. 5: left river-bank close to the source of the River Oulanka.

Epilobium alsinifolium Vill. RBK – R. Rare species found in Karelia at a number of localities in Ks and at three in Kpoc and Kk. Ks. 2: approx. 3 km upstream from the mouth of Lohioja brook, brook–side spring fen.

Epilobium davuricum Fisch. ex Hornem. RBK – R. Rare species known in Karelia in Ks and at least one site in Kk. Ks. 1: approx. 0,5 km south from the frontier post, spruce swamp. 2: approx. 2 km upstream from the mouth of Lohioja brook, brook-side spring fen. 3: riverside spuce swamp approx. 3 km upstream from the mouth of the River Mäntyjoki.

Epilobium hornemannii Reichenb. RBK – R. Rather rare species, the occurrence of which in Karelia is chiefly confined to Ks as well as a few sites in Kpoc and Kk Kpoc. 2: south–western shore of Lake Kivijärvi, spring mire; approx. 4 km east of Lake Latvajärvi, brook–side spruce forest; 3: 5 km south–west from Lake Kormilanjärvi, spring mire. 4: approx. 5 km north–west of Lake Piirtojärvi, spruce swamp. 5: approx. 3 km north of Lake Venehjärvi, brook–side spruce forest. 6: approx. 4 km north–west from Lake Haukilampi, spring mire in the base of an esker. Ks. 2: approx. 2 km upstream from the mouth of Lohioja brook, brook–side spring fen. 3: riverside spring fen approx. 2 km upstream from the mouth of the River Mäntyjoki. 5: north slope approx. 250 m above sea level, brook–side fen. Kk. 1: approx. 0,5 km to the north of Lake Kalliojärvi, brook–side spruce swamp. 2: the River Kuhka approx. 0,5 km downstream from the bridge, spring mire in a riverside spruce forest. 10: south–eastern slope approx. 300 m above sea level, spring fen.

Angelica archangelica L. RBK – R. Rare species known in Karelia from a few localities in Ks and Kk, including the shores of the White Sea (Kindo Peninsula: Vekhov & Bogdanova 1971). Recently found in Kton. Ks. 3: small island covered by bushes at the mouth of the River Mäntyjoki. Kk. 6: approx. 0,5 km downstream from the bridge, riverside. 7: approx. 1 km upstream from Kivakkakoski Rapids, riverside.

Loiseleuria procumbens (L.) Desv. RBK – R. Rare species occurring at only a very few localities in Ks and Kk and two localities in Kpoc (Kuzova Islands: Erkamo 1947). Ks. Ukontunturi Fell. Kk. Päänuorunen Fell. Kivakka Fell (all finds within the oroboreal belt).

Phyllodoce caerulea (L.) Bab. RBK – R. Rare species found in Karelia at a few localities in Ks and Kk, including the shores of the White Sea (Kindo Peninsula: Vekhov & Bogdanova 1971). Ks. Possosiro Fell. Kk. Päänuorunen Fell, Kivakka Fell (all finds within the oroboreal belt).

Thymus subarcticus Klok. et Schost. RBK – V. Very rare species known only from a few localities in Ks, Kk (Jalas, 1947, 1950), recently found in Kpoc (Russkiy Kuzov Island). Intermediates between T. serpyllum and T. subarcticus are not as rare in terms of distribution area as the progenitor species themselves. Some samples from southern Karelia (Kon, Karhumäki and Radkole Island, the latter was reported as T. subarcticus by Kuznetsov 1993) are very similar to those occurring further north but perhaps belong to T. serpyllum L. Kpoc. 7: Lake Kokkojärvi, eastern shore, on

sandy beach, abundant. Ks. Leppic. 1: sandy island in the mouth of the River Oulankajoki. 3: sandy beach close to the mouth of the River Mäntyjoki. Kk. 10: eastern slope of Päänuorunen Fell close to the summit, on cliffs in the oroboreal belt .

Pinguicula alpina L. RBK – R. Rare plant found in Karelia mainly in Ks, as well as in Kk, Kpoc and Kon (only one or two sites for the last–mentioned three provinces). Ks. 3: Mäntykoski, on dolomite cliffs; approx. 1 km upstream from the rivermouth, riverside spring fen. 2: approx. 2 km upstream from the mouth of Lohioja brook, brook–side spring fen. 1: approx. 1 km south–east from the frontier post, spruce swamp with springs. Kk. 6: approx. 1 km downstream from the bridge across the River Oulanka, riverbank.

Lobelia dortmanna L. RBR – R; RBK – I. Rather common in Karelia except in the two northernmost provinces Ks and Kk and three eastern provinces Kpor, Kton, Kp, where it has been found at only a very few localities. Kpoc. 2: Lake Latvajärvi. Lake Kivijärvi, north–eastern shore. 4: Lake Piirtojärvi. Lake Vitsajärvi. Lake Kaunisjärvi. 7: Lake Kokkojärvi. Kk. 3: Lake Karnisjärvi.

Cicerbita alpina (L.) Wallr. RBK – R. Rare species occurring in Ks and in a few localities in Kk. Ks. 5: northern slope approx. 300 m above sea level, brook–side forest. Kk. 4: western slope, approx. 350 m above sea level, on the margin of fen and spruce forest. 6: on the right bank of the River Oulanka approx. 1 km downstream from the bridge, wet spruce forest. 10: eastern slope approx. 300 m above sea level, brook-side forest. 7: approx. 1 km north of Kivakkakoski Rapids, brook–side spruce forest. 3: left bank of the River Tavajoki approx. 1,5 km upstream from the bridge, riverside spruce forest.

Other remarkable species

Diplazium sibiricum (Turch.) Jermi. Sparsely distributed species not previously found in the Kl and Ks provinces of western Karelia. Kpoc. 1: Lake Hoikkajärvi, north–eastern shore, alluvial herb–rich spruce forest (abundant); Lake Kivijärvi, south–western shore, spring fen. Kk. 5: spruce swamp approx. 1 km downstream from the source of the river. 6: spruce swamp approx. 0,5 km north–west from Kivakkakoski Rapids.

Pteridium aquilinum (L.) Kuhn. This species is very common to southern Karelia, especially in tectonic landscapes, but very rare in northern Karelia where it has been found at less than ten localities. Kpoc. 1: Lake Hoikkajärvi, north–eastern shore, alluvial herb–rich spruce forest. Kk. Pääjärvi: approx. 0,5 km north of the settlement, herb–rich forest on the shore of a small unnamed lake. 5: approx. 1 km downstream from the source of the River Oulanka, herb–rich riverside spruce forest.

Helictotrichon pubescens (Huds.) Pilger. Very rare species connected with anthropogenic habitats (meadows). It is known from approx. five localities, mainly in Kl. Kk. 7: on meadowland. Only the second finding of the species in northern Karelia. Reported for the first time in Paanajärvi National Park.

Carex tenuiflora Wahlenb. Rare species distributed very sparsely throughout the whole of Karelia and known to occur at less than twenty sites. Kpoc. 4: 3 km upstream from the bridge across the River Akhkiva, tall sedge–dwarf shrub alluvial pine forest. The first finding of the species in Karelia during the past five decades.

Cocciganthe flos-cucul (L.) Fourr. This species is very common in southern Karelia and along the shores of the White Sea but very rare in inland northern Karelia. Kk. 7: on meadowland. First recording for Paanajärvi National Park.

Moehringia trinervia L. Clairv. The species is fairly common in the southernmost regions of Karelia (Kl, Kol, Kp, Kon, Kton). In northern Karelia it has previously only been reported in the village of Keret (Kk, Beketov, 1888). Kpoc. 7: riverside herb–rich spruce forest near Kumi Rapids.

Thlaspi caerulescens G. et C. Presl. This species is very common in the area of Lake Ladoga (Kl); recently also found in Kol (Kolatselga, Pazhala, Svyatozero) and Kon (Lelikovski Island). This is the first finding in northern Karelia. Kpoc. 1: the abandoned village of Ladvozero, on meadowland, abundant.

Impatiens noli-tangere L. A rather rare species known only from the southernmost regions of Karelia (south to 62° 30'). The first finding in northern Karelia. Kpoc. 7: riverside forest with numerous springs near Kumi Rapids.

Viburnum opulus L. The species is very common in southernmost Karelia but found only in a few localities north of the Kuito lakes. Kpoc. 4: 3 km west of Lake Kaunisjärvi, brook–side spruce forest. Kk. 3: 3 km upstream from the bridge, riverside spruce forest.

Valeriana sambucifolia Mikan.

The only previous reporting of this species was on Valamo Island in Kl (Pobedimova & Gladkova 1966). Kpoc. 1: Latvajärvi, on meadowland.; Pahkomienvaara, on meadowland. Ks.

Most important localities for vascular plants

Lake Kormilo area. (compartments 4–11, Latvajärvi Forestry District)

Old growth forests predominate here. Rare and indicator species such as *Dryopteris expansa, Matteuccia sthruthiopteris, Goodyera repens, Corallorhiza trifida, Listera cordata, Stellaria calycantha, Ranunculus lapponicus,* and *Epilobium hornemannii* are rather common.

Lake Latvajärvi area. (compartments 160–195, Vuonninen Forestry District)

Protected *D. cruenta* (O. F. Muel.) Soo and *D. traunsteineri* (Saut.) Soo s. l. were found here. Rare and protected species such as *Matteuccia sthrutioptheris, Stellaria calycantha, Ranunculus lapponicus, Epilobium hornemannii,* and *Galium triflorum* are typical of brook–side spruce forests.

Kaunisjärvi – Vitsajärvi – Piirtojärvi lakes area. (compartments 106–113, 136–142, 173–175 Vuokkiniemi Forestry District). Rare and indicator species such as *Dryopteris expansa, Isoetes setacea, I. lacustris, Agrostis borealis, A. clavata, Melica nutans, Milium effusum, Elymus caninus, Carex tenuiflora, Platanthera bifolia, Actaea erythrocarpa, Ribes scandicum, Viola selkirkii, Galium triflorum, Viburnum opulus,* and *Lobelia dortmanna* were found here.

Lake Haukijärvi area. (compartments 157–159, 179–184 Vuonninen Forestry District). Rare, protected and indicator species such as *Polypodium vulgare, Woodsia ilvensis, Poa alpigena, Melica nutans, Milium effusum, Carex flava, Stellaria calycantha, Epilobium hornemannii,* and *Daphne mezereum* were found here.

Valley of River Vuonnisjoki. (right bank) downstream from Lake Kokkojärvi. Species such as *Cystopteris fragilis, Calamagrostis arundinacea, Carex ericetorum, Carex buxbaumii, C. capillaris, C. loliacea, C. flava, Actaea erythrocarpa, Potentilla crantzii, Ranunculus lapponicus, Ribes scandicum, Circaea alpina, Epilobium hornemannii, Impatiens noli-tangere,* etc. have been found here.

Kalliojärvi area. Such species as *Cystopteris fragilis, Matteuccia sthruthiopteris, Carex rhynchophysa, Saxifraga nivalis, Actaea erythrocarpa, Epilobium hornemannii,* and *Petasites frigidus* were found here.

Valley of the Kuhkajoki and Pontsalojoki rivers. Rare and indicator species such as *Equisetum scirpoides, Matteuccia sthrutiopteris, Stellaria calycantha, Actaea erythrocarpa, Circaea alpina, Epilobium hornemannii,* etc. occur here.

Lower part of the Tavajoki river valley. Several rare and indicator plant species, e.g. *Stellaria calycantha, Steris alpina, Potentilla crantzii, Viburnum opulus, Cicerbita alpina,* etc. were found here.

Ukontunturi Fell. A large number of protected typical arcto–alpine species such as *Diphasiastrun alpinum, Juncus trifidus, Arctous alpina, Loiseleuria procumbens,* etc. were found in the oroboreal belt.

Päänuorunen-Tsipringa area. A large number of rare and protected species such as *Diphasiastrun alpinum, Juncus trifidus,Convallaria majalis, Cypripedium calceolus, Lathyrus vernus, Arctous alpina, Loiseleuria procumbens, Phyllodoce caerulea, Epilobium hornemannii, Thymus subarcticus, Cicerbita alpina,* etc. are of rather common occurrence.

Hepatics

Present knowledge of hepatics in Karelia

The study of hepatics in Karelia was initiated in the 19th century by Olbricht. His collection was investigated by Trinius (Bergschtresser 1838). Important contributions were also made by Nylander (1852), Nylander & Saelan (1859) and Lindberg (1879), who published the first data on the distribution of hepatics in Karelia.

Since those days further reports on the hepatics of Karelia have been published. Most of the available data was summarised in 'Manual of liverworts of the European north of the USSR' (Savicz & Ladyzhenskaya 1936). However, this work contains very little information on species distribution. Furthermore, it includes a number of doubtful records.

'Illustrated moss flora of Fennoscandia I: Hepaticae' (Arnell 1956) is the most valuable publication dealing with the hepatics of Fennoscandia. This book includes more or less detailed information on the distribution of 151 species in the provinces of Karelia.

Various common hepatic species are mentioned in numerous publications on mosses. Auer (1944) revised the available data on the hepatics of Kuusamo. Halonen & Ulvinen (1996) compiled a list of moss species (including hepatics) for Paanajärvi National Park on the basis of both Auer's and their own data. Some data on the epixylic hepatics of the coniferous forests of the Vuokkijoki area have recently been published by Pyykkö (1996). This last–mentioned publication, however, contains some doubtful records. For example, the author mentions *Lophozia wenzelii* and *Cephalozia loitlesbergeri* occurring on decaying wood. If true, this is a most surprising observation.

Local florulas

A study was made of the species composition of nine local florulas.

1) Mires 10 km north of Kostamus
2) The area close to Lake Kokkojärvi and the River Vuonnisjoki
3) The banks of the River Tavajoki
4) Kivakkatunturi Fell
5) The source of the River Oulanka
6) Leppijoki river basin
7) Päänuorunen Fell
8) The abandoned village of Vartiolampi–Kivakkakoski Rapids
9) The surroundings of the Pääjärvi settlement, and the Pontsalojoki and Kuh kajoki river basins.

A total of 82 species of hepatics was found (Appendix 3). Most of them are of more or less common in Fennoscandia and many are widely distributed throughout the whole of the boreal zone. Oro–hypoarctic species such as *Plectocolea obovata*, several arcto–alpine species (*Harpanthus flotovianus, Scapania paludicola, Sphenolobus minutus, Tritomaria quinquedentata*), and mountain hepatics (*Scapania undulata, Sphenolobus saxicola*) were amongst the species found.

Several species recorded, such as the temperate *Fossombronia* sp., the arctic *Orthocaulis binsteadii* and the boreal *Riccardia multifida*, are of scant distribution in Karelia.

Indicator species

Mosses and, in particular, hepatics are considered to be good indicators of old growth forest (Söderström 1988, Hytteborn 1987, Gustafsson & Hallingbäck 1988, Jonsson & Esseen 1990, Andersson & Hytteborn 1991, Hallingbäck 1991, Esseen et al. 1992, Frisvoll & Presto 1997). Hallingbäck (1991), for example, has listed a number of indicator hepatics for Sweden but most of these are either absent or very rare in Karelia. During the survey of old growth forests a total of forty–six species were found (those marked with an asterisk in appendix 3). Below we present a list of hepatics which may be used as indicators of old growth forest in north–western Karelia.

Calypogeia muelleriana

On decaying wood, in depressions and at the shady bases of small hillocks. Kpoc. 7: pine forest nearby Kumi Rapids. Ks. 4: western slope, approx. 300 m above sea level. Kk. 9: brook–side spruce forest near the bridge across the River Kuhka, approx. 200 m downstream from the rapids.

Crossocalyx hellerianus

On decaying wood (except in very shady forests). Kpoc. 2: common in old growth pine forests. Kk. 3: common in coniferous forests. 6: common in coniferous forests. 9: old growth spruce forest on the bank of the River Kuhka some 200 m downstream from the rapids.

Harpanthus flotovianus.

On the soil in a brook-side spruce forest. Kpoc. 1: spruce forest along the southern edge of a mire. 7: pine–spruce forest near Kumi Rapids. Kk. 3: riverside spruce forest about 1 km upstream from the bridge. 8: riverside spruce forest in the lower part of Leppijoki river basin. 10: brook–side spruce forest on the south–eastern slope of Päänuorunen Fell, approx. 350 m above sea level. 9: brook–side spruce forest near the bridge across the River Kuhka.

Lophozia ascendens

On decaying wood in coniferous forests. Kk. 3: ca. 1 km upstream from the bridge.

Orthocaulis attenuatus

On decaying wood in coniferous forests. The species was found in old growth forests in many localities. Kpoc. 7. Kk. Tavajoki, Kivakkatunturi, the source of the River Oulanka, Leppijoki, Pääjärvi.

Plagiochila major

On the soil in a brook-side spruce forest in the shade of ferns (mainly Athyrium filix-femina). Kk. 5: spruce forest in a depression about 1 km north–east from the source of the River Oulanka.

Riccardia palmata

On decaying wood in an old growth pine forest together with Cephalozia spp. Kk. 3: approx. 1 km upstream from the bridge.

Schistochilopsis incisa
On decaying wood in coniferous forests. Kpoc. 7: pine forest near Kumi Rapids. Kk. 3: common in old growth forests. 7: riverside spruce forest approx. 1 km upstream from Kivakkakoski Rapids.

Rare, threatened and other remarkable species

Hepatics are not included in the Red Data Book of Karelia (Ivanter & Kuznetsov 1995) owing to a lack of knowledge of this group. The list of hepatics presented below is, therefore, a first step in the determination of rare and threatened species for the north–western part of Russian Karelia. The list includes twenty–nine taxa. Five of them are reported in Karelia for the first time (marked by two asterisks) and a further eighteen are new for Paanajärvi National Park (marked by one asterisk). The distribution of the most interesting hepatic species in Karelia is mapped (Figs. 22-36).

1. **Calypogeia muelleriana* Kpoc. Kokkojärvi. Kk. Kivakka Fell, River Kuh kajoki.
2. **Calypogeia sphagnicola* Kpoc. Kostamus, Kokkojärvi. KK. Tavajoki, Lep pijoki, Päänuorunen Fell, Kivakkakoski.
3. **Cephalozia leucantha* Kpoc. Kostamus, Kokkojärvi. KK. Tavajoki, Ki vakka Fell, Kivakkakoski.
4. *Cephalozia loitlesbergeri* Kpoc. Kokkojärvi.
5. ***Cephaloziella* cf. *arctogena* KK. Leppijoki.
6. **Cephaloziella divaricata* KK. Leppijoki
7. **Crossocalyx hellerianus* Kpoc. Kokkojärvi. KK. Tavajoki, Leppijoki, Ri ver Kuhka.
8. *Fossombronia* sp Kpoc. Kokkojärvi.
9. ***Jungermannia borealis* Kpoc. Kokkojärvi.
10. *Lophozia ascendens* KK. Tavajoki.
11. *Lophozia confertifolia* Kpoc. Kokkojärvi. KK. Tavajoki, Leppijoki.
12. ***Lophozia jurensis* KK. Kivakkakoski
13. ***Lophozia rufescens* KK. Kivakka Fell, Päänuorunen Fell.
14. **Marchantia alpestris* KK. Vartiolampi, Kivakkakoski.
15. **Nardia insecta.* Kpoc Kokkojärvi. KK. Source of the River Oulanka, Vartiolampi, Kivakkakoski.
16. **Nardia scalaris* KK. Leppijoki, Päänuorunen Fell.
17. **Odontoschisma elongatum* Kpoc. Kostamus, Kokkojärvi. KK. Tavajoki, Kivakka Fell.
18. *Orthocaulis binsteadii* KK. Kivakka Fell.
19. *Pellia epiphylla* Kpoc. Kostamus.
20. **Plagiochila major* KK. Source of the River Oulanka.
21. **Plectocolea obovata* Kpoc. Kostamus, Kokkojärvi. KK. Tavajoki, Kivak ka Fell, source of the River Oulanka, River Kuhkajoki.
22. *Riccardia multifida* Kpoc. Kostamus.
23. *Riccardia palmata* KK. Tavajoki.
24. *Scapania hyperborea* KK. Päänuorunen Fell.
25. **Scapania praetervisa* KK. Tavajoki, source of the River Oulanka, Päänuo runen Fell
26. ***Scapania scandica* Kpoc. Kostamus, Kokkojärvi. KK. Tavajoki, Vartio lampi, Kivakkakoski.
27. **Solenostoma caespiticium* KK. Source of the River Oulanka, Leppijoki.

28. **Solenostoma confertissimum* Kpoc. Kostamus, KK. Leppijoki, Vartiolam pi, Kivakkakoski.
29. *Tetralophozia setiformis* Kpoc. Kokkojärvi. KK. Kivakka Fell, source of the River Oulanka, Päänuorunen. The species is very common in the oroboreal belt. The find close to Kumi Rapids is highly significant as this site is some 150 km south of the generally accepted southernmost extreme of distribution for the species.

Most important localities for hepatics

1) Spruce swamps on the margins of fens 10 km north from the city of Kostamus. The rare species *Riccardia multifida* was found here.
2) Kumi Rapids on the River Vuonnisjoki. The discovery here of the hepatic species *Jungermannia borealis* is the first recording for the whole of Karelia. The extremely rare *Cephalozia loitlesbergeri* and *Tetralophozia setiformis* were also both found here.
3) Old growth pine forests situated on the banks of the River Tavajoki about 1 km upstream from the bridge. The extremely rare species *Riccardia palmata* and *Lophozia ascendens* were found at this site.
4) The oroboreal belt of Kivakka Fell. Many species typical of mountains and tundra were found here, including *Anthelia juratzkana, Gymnomitrion concinnatum, Lophozia rufescens,* and *Orthocaulis binsteadii.*
5) The oroboreal belt of Päänuorunen Fell. Many species typical of mountains and tundra were found here, including *Anthelia juratzkana, Gymnomitrion concinnatum, Lophozia rufescens,* and *Scapania hyperborea.*
6) Rocks on the left bank of the River Oulanka nearby Kivakkakoski Rapids. The discovery here of *Lophozia jurensis* is the first recording for the whole of Karelia.

Lichens

The history of lichen studies in the region

Considering the vast area along the Russian–Finnish border north of Lake Tuulijärvi, thorough studies of lichen flora have been made only from the Paanajärvi area (Vainio 1881, 1883, 1921, 1922, 1927, 1934, Ahlner 1936, 1937, Auer 1943, Kotilainen 1944, Ulvinen et al. 1981, Halonen 1993). Some data exists for the Tuulijärvi–Kostamus–Kalevala area thanks to the efforts of E. Vainio (1881). Observations in the Kalevala area of species such as *Lecidea limosa* Ach., *Leptogium subtile* (Schrad.) Torss., *Mycobilimbia tetramera* (DeNot) comb. ined., *Rhizocarpon geminatum* Körb. and *Solorina crocea* (L.) Ach. have been made. Two species *Melanelia commixta* (Nyl.) Thell and *Umbilicaria hyperborea* (Ach.) Hoffm. were collected on Karpovaara by Yu. D. Tsinzerling in the 1930s. Both specimens are stored in LE, the record of the first–mentioned being published by Rassadina (1950).

More recent data is available for the Kostamus Nature Reserve (Adrianova & Kashevarov 1991, Fadeyeva & Dubrovina 1995, 1997) and for the proposed national parks of Kalevala and Tuulijärvi (Fadeyeva 1998a, 1998b). In 1996, as part of a

botanical field trip headed by Prof. T. Ahti, some areas to the north of Kostamus were briefly visited and data collected. All finds from the area under consideration have recently been summarised (Fadeyeva et al. 1997).

Local florulas

The following areas were studied:

- the north–eastern part of the Kostamus Nature Reserve and adjacent are as bordering the reserve (Lake Kiitehenjärvi);
- the area approx. 10 km north from the city of Kostamus;
- the surroundings of the abandoned village of Venehjärvi;
- Lake Kaunisjärvi and surroundings.

The species composition of local lichen florulas is presented in Appendix 4. The nomenclature of species and infraspecies follows Vitikainen et al. (1997). The order of families accords with Eriksson & Hawksworth (1988, 1990) while recent additions (Andreev et al., 1996; Andreev, 1998) were also taken into account.

Indicator species

Lichens are considered to be good indicators of old growth forest in both North America (Goward 1994) and Europe (Rose 1976, Kuusinen et al. 1994, Kuusinen 1996). In Finland, for example, thirty–four lichen species have been accepted for such purposes (Kuusinen et al. 1994). During the course of the present study twenty–two of these species were found in old growth forests in the area under consideration (Appendix 4).

The occurrence of indicator lichen species was recorded as follows: 0 = species not found, 1= species found on one tree, 2 = species found on two to three trees or occurring in abundance on one particular tree, 3 = species found on not less than four trees.

Rare or threatened species

Information on those lichen species listed in the Red Data Book of Russia (RBR, Borodin et al. 1988), the Red Data Book of Karelia (RBK, Ivanter & Kuznetsov 1995) and the Red Data Book of East Fennoscandia (RBEF, Kotiranta et al. 1998), which have been found in the areas surveyed is presented below. Categories of protected species are as follows: V – vulnerable; R – rare; I – indeterminate or in need of monitoring. The traditional Latin abbreviations for the biogeographical provinces of Karelia have been employed, thus: Kl – Karelia ladogensis, Kol – Karelia olonetsensis, Kp – Karelia pudogensis, Kb – Karelia borealis, Kon – Karelia onegensis, Kton – Karelia transonegensis, Kpoc – Karelia pomorica occidentalis, Kpor – Karelia pomorica orientalis, Ks – Regio kuusamoënsis, and Kk – Karelia keretina.

A total of nine Red Data Book species were found in some fifty localities. Thirty–seven of these contained the rather common species *Bryoria fremontii* and *Lobaria pulmonaria*. The distribution of the most valuable species is mapped (Figs. 38–45).

Annotated list of rare and protected lichen species

Arthonia incarnata Th. Fr. ex Almq. Recorded for the first time in Karelia. Kpoc. 2 km north–west of Lake Kaunis, on the base of the trunk of *Salix caprea*.

Bryoria fremontii (Tuck.) Brodo & D.Hawksw. RBR – V, RBK – I. The species has previously been recorded at approx. twenty sites across the whole of Karelia. Over the past decade it has been found at numerous sites mainly in northern Karelia. It is

rather common in the Kostamus Nature Reserve and proposed Kalevala National Park. Kpoc. Latvajärvi., Piirtojärvi., Kormila: collected or observed at many sites. Venehjärvi 5 km east of the village, on pine trunks. Kumi Rapids on the River Voinitsa, on spruce branches; 5 km west of the village of Vuonninen, Khama stream, on spruce branches; 3 km north–west of Lake Haukijärvi, on spruce branches. 10 km south–west of Kostamus, on pine trunks; north–eastern part of Kostamus Nature Reserve, on pine trunks and spruce branches. Kk. Ohtojärvi: 1 km north–east of Kalliojärvi, on spruce branches and pine stems. Pääjärvi: 0,5 km north of the settlement, on pine branches and trunks.

Evernia divaricata (L.)Ach. RBK – I. A rare species recorded at some fifteen localities in southern Karelia (Kl, Kb, Kon, Kol) as well as at three sites in Ks and individual sites in Kpoc and Kton. Kpoc. Piirtojärvi: 2 km north–west of Lake Kaunisjärvi, on spruce branches.

Ramalina dilacerata (Hoffm.) Hoffm. RBK – I. A rare species known from approx. ten localities mainly in Kl and Kon as well as from one or two sites in Kb, Kton, Ks. Kpoc. Piirtojärvi: 2 km west of Lake Kaunisjärvi, on the trunk of *Salix caprea.* 3 km north–west of Lake Kaunisjärvi, the River Akhkiva, on *Salix caprea.* Western shore of Lake Venehjärvi, on the trunk of *Salix caprea.* North–eastern part of the Kostamus Nature Reserve, on the trunk of *Salix caprea.*

Stereocaulon dactylophyllum Flörke. RBR – V, RBK – R. A very rare species known to occur in only three localities in Kl. Kpoc. north–eastern part of the Kostamus Nature Reserve, on outcrops of bedrock.

Lobaria pulmonaria (L.) Hoffm. RBR – V, RBK – I. A fairly common species distributed throughout Karelia, occurring in all provinces. This species has shown clear signs of decline over the past few decades as a result of forest felling and air pollution. Kpoc. South–eastern shore of Lake Lapukka, on the trunk of aspen; 1 km east of the central stretch of eastern shoreline of Lake Lapukka, on the trunk of *Salix caprea.* South–west from Lake Kormilo, collected and observed at numerous localities on the trunks of aspen, willow and birch. 3 km west of Lake Kaunisjärvi, on the trunk of aspen; 1 km north–east of Lake Piirtojärvi, on *Salix caprea.* 4 km east of the village of Venehjärvi, on the trunk of *Salix caprea.* Haukilampi: 7 km west of Vuonninen village, on the trunk of aspen and birch. Kokkojärvi: 5 km downstream from Kumi Rapids, on the trunk of *Salix caprea.* Ks. 2 km upstream from the mouth of Lohioja brook, on *Salix caprea.* Paanajärvi: Ruskeakallio, on calcareous cliffs. Approx. 3 km upstream from the mouth of the Selkäjoki rivulet, on the trunk of *Salix caprea.* 1 km south–east of Ukontunturi, on the trunk of aspen. Kk. Ohtojärvi: eastern shore of Lake Kalliojärvi, on the trunk of aspen. 1 km downstream from the source of the River Oulanka, on the trunk of *Salix caprea.* Siltajoki: 3 km north of the River Oulanka, on the trunk of *Salix caprea.*

Nephroma bellum (Spreng.) Tuck. RBK – V. A rare species known from some fifteen localities throughout Karelia, mainly in Kl, Kon and Ks, as well as in Kol, Kton, Kpoc, and Kk. Kpoc. North–eastern part of the Kostamus Nature Reserve, on *Salix caprea.* Piirtojärvi: 3 km north–west of Lake Kaunisjärvi, on *Salix.* 2 km west of Lake Kaunisjärvi, on *Salix.* 5 km south of Lake Kaunis, on *Salix.* 3 km east of Venehjärvi village, on *Salix.*

Dermatocarpon luridum (With.) J.R. Laundon. A rare species distributed sparsely across the whole of Karelia. It has been found at around ten sites, mainly in Kl and Kon, as well as in Kol, Kpoc and Ks. Kpoc. North–eastern shore of Lake Kiitehenjärvi, on boulders.

Most important localities for lichens

1) Kaunisjärvi–Piirtojärvi lake area (compartments 136–142, Vuokkiniemi Forestry District). The species *Arthonia incarnata* is new for the whole of Karelia. The rare and indicator species *Evernia divaricata* and *Ramalina dilacerata* also occur.

2)Kormilo lake area (compartments 4–11, Latvajärvi Forestry District). Two protected lichen species *Lobaria pulmonaria* and *Bryoria fremontii* are common at this particular site although of much rarer occurrence in all other parts of the investigated territory.

Proposal for the Establishment of New Protected Territories

In the north of the Republic of Karelia along the Russian–Finnish border there still exist large areas of unspoilt mires and forests. According to conservation standards already in force in the countries of northern Europe these areas should be protected. Information on various groups of flora indigenous to such areas has allowed us to make a considered proposal for the protection of specific territories. Thus, on the basis of recordings on vascular plants, lichens and hepatics, the following localities (see also figures 38–45) are considered as potential areas for future protection, as well as for ecological and scientific tourism.

1. The natural fens, transitional and aapa mires, and adjacent old growth forests situated 10 km north of the city of Kostamus. Mesoeutrophic mire species such as *Eriophorum latifolium* and *Carex panicea* are rather common in this site. Species typical of aapa mires, including *Selaginella selaginoibes, Sparganium hyperboreum, Eriophorum gracile, Juncus stygius, Tofieldia pusilla, Dactylorhiza traunsteineri, Hammarbya paludosa, Pinguicula vulgaris* and *Utricularia minor*, are found here, together with *Lycopodiella inundata*. Recordings have also been made of the hepatic species *Riccardia multifida*.

2. Kormilo lake area (compartments 4–10, Latvajärvi Forestry District). Old growth forests of intermediate to high productivity, chiefly of the *Myrtillus* and *Geranium–Myrtillus* types, predominate in this area. Characteristic of the Kormilo area is the relatively high productivity of the soils compared with the poor podzolic soils which cover practically all other parts of the proposed Kalevala National Park. The pine dominated forests of the locality comprise several generations of pine, with individual trees of up to 490 years of age. Herb–rich spruce dominated forests occur in depressions along brooks and contain species such as *Matteuccia sthrutioptheris, Corallorhiza trifida, Listera cordata, Stellaria calycantha, Ranunculus lapponicus,* and *Epilobium hornemannii*. In the drier forests the indicator species *Dryopteris expansa* and *Goodyera repens* were observed at numerous sites. The protected lichens *Lobaria pulmonaria* and *Bryoria fremontii* are also very common. The most northerly recording to date of *Lycopodiella inundata* was made on the paludified shore of an unnamed lake some 0,5 km south of Lake Kormilo.

3. Latvajärvi area (compartments 165–196, Vuokkiniemi Forestry District). A great diversity of *Dactylorhiza* microspecies was found in the transitional and aapa mires, as well as the paludified spruce and pine dominated forests prevalent in this locale. These included *D. x ambigua* (A. Kerner) H. Sundermann *(D. maculata x D. incarnata), D. cruenta* (O. F. Muel.) Soo, *D. curvifolia* (Nyl.) Czer., *D. fuchsii* (Druce) Soo, *D. hebridensis* (Wilmott) Aver., *D. incarnata* (L.) Soo, *D. x lehmanii* (Klinge) Soo *(D. russowii x D. incarnata), D. maculata* (L.) Soo, *D. psychrophila* (Schlechter) Aver., *D. russowii* (Klinge) Holub., *D. sudetica* (Poch ex Reichenb. fil.) Aver. and *D. traunsteineri* (Saut.) Soo *s. str.* Species such as *Matteuccia struthioptheris, Stellaria calycantha, Ranunculus lapponicus, Epilobium hornemannii* and *Galium triflorum* are typical of the brook–side spruce forests found here.

4. Kaunis-Vitsa-Piirtojärvi lakes area (compartments 107–112, 136–141, 171, 173, 175, Vuokkiniemi Forestry District; compartment 1, Latvajärvi Forestry District). The area is covered by pine and spruce dominated forests of heterogenous age structure. Some forests have been used for resin extraction. Compartments 107–108 contain the only site of herb–rich forests within the borders of the proposed Kalevala National Park. Species found there include *Dryopteris expansa, Melica nutans, Milium effusum, Elymus caninus, Platanthera bifolia, Actaea erythrocarpa, Ribes scandicum, Viola selkirkii, Galium triflorum* and *Viburnum opulus.* Extremely rare in Karelia, *Agrostis clavata* has been found at two sites within this area, as too has another rare species, *Carex tenuiflora.* Recordings at several sites have also been made of the protected lichens *Lobaria pulmonaria* and *Bryoria fremontii.*

5. Haukilampi lake area (compartments 157–159, 181–183 Vuonninen Forestry District). This area comprises a rugged and uneven landscape of deep wooded ravines and valleys containing numerous rivers and brooks. Snow often remains in the deep and narrow ravines up until the end of June. The area also includes a beautiful waterfall some ten metres in height. These and other features make Haukilampi a most attractive place for hiking. Several southern species such as *Daphne mezereum, Melica nutans, Milium effusum* and *Carex flava* are of rather common occurrence. This is also home to the only populations of the small fern *Woodsia ilvensis* known to occur in the territory stretching from the Kostamus Nature Reserve up as far as the province of Kk. Small fens located around springs appearing at the base of eskers offer suitable habitats for the species *Poa alpigena, Stellaria calycantha* and *Epilobium hornemannii.*

6. The valley of the River Vuonnisjoki downstream from Lake Kokkojärvi. The sandy beaches of Lake Koko and the famous Kumi Rapids and steep sandy slopes (up to twenty metres in height) on the left hand bank of the River Voinitsa form a highly attractive landscape of great recreational potential. On the left hand bank of the river the forests have been felled but several unspoilt fragments of spruce swamps survive. These are of crucial importance as they contain a rich variety of flora. The right hand banks of River Voinitsa and the areas to the south are covered by primary pine forest and have yielded finds of *Cystopteris fragilis, Calamagrostis arundinacea, Carex ericetorum, Carex capillaris, C. disperma, C. loliacea, C. flava, C. buxbaumii, Moehringia trinervia* (the second recording in northern Karelia), *Actaea erythrocarpa, Potentilla crantzii* (the first recording in the area extending from Kl to Paanajärvi), *Ranunculus lapponicus, Epilobium hornemannii,* and *Impatiens noli–tangere* (the first recording in northern boreal Karelia). The hepatica species *Jungermannia borealis* was recorded for the first time in Karelia while the extremely rare *Cephalozia loitlesbergeri* and *Tetralophozia setiformis* were also found.

7. Kalliojärvi old growth forests. This area is covered with untouched mesic forest. Pine dominated stands are of widespread distribution while areas of spruce are usually situated in depressions. *Matteuccia sthruthiopteris, Carex rhynchophysa, Actaea erythrocarpa,* and *Petasites frigidus* have all been observed here. On the rocky slopes of a wooded ravine a rare petrophyte species *Saxifraga nivalis,* as well as the more common *Cyctopteris fragilis,* have both been found. The protected lichens *Lobaria pulmonaria* and *Bryoria fremontii* are of prolific occurrence.

8. The River Kuhkajoki from the rapids near the Pääjärvi – Paanajärvi road, downstream as far as the River Pontsalojoki. The valley of the River Kuhkakoski is of great recreational value to local people. The Kuhka Rapids are the largest in the whole of lowland Karelia. Several rare indicator plant species such as *Matteuccia sthrutiopteris, Stellaria calycantha, Actaea erythrocarpa,* and *Epilobium hornemannii* have been found there.

9. The lower part of Tavajoki river valley. This picturesque river with its many beautiful rapids and rocky banks attracts both tourists and fishermen. Several rare and indicator plant species, e.g. *Steris alpina, Potentilla crantzii, Cicerbita alpina*, etc. have been found, along with two very rare species of hepatics, *Riccardia palmata* and *Lophozia ascendens*.

10. The area extending from Ukontunturi Fell to the River Tavajoki. Fragments of untouched spruce dominated forest are preserved in this area. Typical arcto–alpine species, including *Diphasiastrun alpinum, Juncus trifidus, Arctous alpina, Loiseleuria procumbens* and *Phyllodoce caerulea*, have been found in the oroboreal belt. This is the southernmost distribution extreme so far recorded in Eastern Fennoscandia for several of these species.

11. Päänuorunen–Tsipringa area. Päänuorunen Fell is characterised by its special geological structure (Systra 1996). Relatively untouched pine dominated forests of heterogenous age structure are predominant. Signs of previous selective logging take the form of old pine stumps. Evidence of forest fires may be observed throughout all the pine stands growing on dry soils. Untouched spruce dominated forests occupy the moist areas and the upper slopes of the fell. Herb–rich forests, generally uncommon to northern Karelia, abound in many species of southern vascular plants. Numerous rare and protected species such as *Convallaria majalis, Cypripedium calceolus, Lathyrus vernus, Epilobium hornemannii, Cicerbita alpina*, etc. and fell species *Diphasiastrun alpinum, Juncus trifidus, Arctous alpina, Loiseleuria procumbens, Phyllodoce caerulea, Thymus subarcticus*, etc. have been found in this area. Recordings have also been made of a number of hepatics typical of mountains and tundra, including *Anthelia juratzkana, Gymnomitrion concinnatum, Lophozia rufescens*, and *Scapania hyperborea*. This site is not yet under protection and is, therefore, under continuous threat of imminent felling. We therefore unequivocally urge that the entire area north and north–east of the eastern border of the current territory of the national park, extending as far as Lake Tsipringa and including the Perävaara and Päänuorunen fells, be included within the protected territory at the earliest possible date.

By way of conclusion we propose the establishment of several new protected territories of varying status within the area surveyed, as follows.

- A mire reserve – locality 1.
- A landscape reserve – localities 6,7, 8, 9, 10.
- Locality 11 should be incorporated into the Paanajärvi National Park.
- Localities 2–5 should be included within the proposed Kalevala National Park.

Acknowledgements

This study was financed by the EU LIFE fund (grant B4–3200/96/543). We are very grateful to Raimo Heikkilä, Director of the Friendship Park Research Centre, Kainuu Regional Environmental Centre, for initiating the present study. We are also grateful to Dr. N.A.Konstantinova (KPABG) for her help in checking and verifying species of hepatics new to Karelia and Paanajärvi National Park, as well as for valued assistance with complex genera such as *Cephaloziella* and *Lophozia*. Furthermore, we are indebted to Dr. L. Averyanov (LE), Dr. A. Sennikov (LE) and Dr. N. Tzvelev (LE) for their help in checking samples of certain vascular plants (genera *Poa, Dactylorhiza, Hieracium*).

References

Ahlner, S. 1936: Einige Flechtenfunde aus Kuusamo (Nord–Finnland) – Mem. Soc. F. Fl. Fenn. 12: 52–56.

Ahlner, S. 1937: Flechten aus Nordfinnland – Ann. Bot. Soc. Zool. – Bot. Fenn. "Vanamo". 9(1): 1–48.

Andersson, L. I. & Hytteborn, H. 1991: Bryophytes and decaying wood – a comparison between managed and natural forests. – Holarct. Ecol. 14: 121–130.

Andreev, M. P., Kotlov, Yu. V. & Makarova, I. I. 1996: Checklist of lichens of the RussianArtic (including lichenicolous fungi) – Bryologist. 99(2).

Angelstam, P. & Majewski, P. 1996: Reference landscapes for improved management in eastern and western Europe. – In: Bachmann, P. et al. (eds.). Assessments of biodiversity for improved forest management. EFE Proc. 6: 111–123.

Angelstam, P. & Mikusinski, G. 1994: Woodpecker assemblages in natural and managed boreal and semiboreal forests – a review – Ann. Zool. Fenn. 31: 157–172.

Arnell, S. 1956: Illustrated moss flora of Fennoscandia 1: Hepaticae. 308 pp. Lund.

Auer, A. V. 1943: Kasvistollisia havaintoja Pohjois–Suomesta III – Memor. Soc. F. Fl. Fenn. 19:44–57.

Auer, A.V. 1944: Kuusamon maksasammalkasviston aineistoa. – Ann. Bot. Soc. Zool. – Bot. Fenn. "Vanamo" 21(1):1–44.

Berg, Å., Ehnström, B., Hallingbäck, T., Jonsell, M. & Weslien, J. 1994: Thereatened plant, animal and funcus species in Swedish forests: Distribution and habitat associations – Conservation Biology. 8(3): 718–731.

Bergschtresser, K. F. 1838: The experience of the description of the Olonetz District. – St.Petersburg. 135 pp. (In Russian)

Belousova, N. A., Kuchko, A. A, Sazonov, S. V. & Kravchenko, A. V. 1992: State and developmental prospects of the system of protected natural territories of Karelia. – In: Kuchko, A. A. (ed.). Protected natural territories and natural monuments of Karelia. – Petrozavodsk. p. 6–17. (In Russian with English summary)

Borodin, A. M. et al. (eds.). 1988: Red Data Book of the RSFSR. – Moskow. 487 pp. (In Russian)

Cherepanov, S. K. 1995: Vascular plants of Russia and adjacent states. – St. Petersburg. 992 pp. (In Russian with English summary)

Ehnström, B. & Walden, H. 1986: Faunavård i skogsbruket Skogsstyrelsen. Jönköping.

Eriksson, O. E. & Hawksworth, D. L. 1988: Outlineof the ascomycetes 1988 – Systema ascomycetum 7(2): 119–315.

Erkamo, V. 1947: Bergroths botaniska undersokningar i Karelia Pomorica – Acta Soc. F. Fl. Fenn. 67(1): 83 pp.

Esseen, P. A., Ehnström, B., Ericson, L. & Sjöberg, K. 1992: Boreal forests – the focal habitats of Fennoscandia – In: Hansson, L. (ed.), Ecological principles of nature conservation: – Elsevier, London. 252–325.

Fadeyeva, M. & Dubrovina, N. 1995: Lichens of industrial zone of the city of Kostomuksha and Kostomuksha Nature Reserve – In: Kravchenko, A. V. et. al. (eds.). Floristic studies in Karelia. Petrozavodsk. 2: 63–84. (In Russian with English summary).

Fadeyava, M. & Dubrovina, N. 1997: Notes on the lichen flora of the Kostomuksha Nature Reserve – In: Lindholm, T., Heikkilä, R. & Heikkilä. M. (eds.) Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve Friendship. 124: 125–135. Helsinki.

Frisvoll, A. A. & Presto, T. 1997: Spruce forest bryophytes in central Norway and their relationship to environmental factors including modern forestry. – Ecography 20: 3-18.

Goward, T. 1994: Notes on oldgrowth–dependent epiphytic macrolichens in inlabd British Columbia, Canada – Acta Bot. Fenn. 150: 31–38.

Gromtsev, A. N. (ed.). 1998: Inventory of natural complexes and ecological feasibility study of Kalevala National Park. – Petrozavodsk.

Gustafsson, L. & Hallingbäck, T. 1988: Bryophyte flora and vegetation of managed and virgin forests in south–western Sweden – Biol. Cons. 44: 283–300.

Gustafsson, L. 1996: Biodiversity assessments in Swedish forestry based on data of red–listed species. – In: Bachmann, P. et al. (eds.). Assesments of biodiversity for improved forest management. EFE. P. 143–148.

Haila, Y., Hanski, I. K., Niemelä, J., Punttila, P., Raivio, S. & Tukia, H. 1994: Forestry and boreal fauna: matching management with natural forest dynamics – Ann. Zool. Fenn. 31: 187–202.

Hallingbäck, T. 1991: Mossor som indikerar skyddsvärd skog – Svensk. Bot. Tidskr. 81: 321–332.

Halonen, P. 1993: The lichen flora of the Paanajärvi National Park. – Oulanka Reports. 12: 45–54.

Halonen, P. & Ulvinen, T. 1996: The bryoflora of Paanajärvi National Park. – Oulanka Reports 16:23–32.

Hulten, E. 1971: Atlas över växternas utbreding i Norden. – Stockholm. 56+531 pp.

Hytteborn, H., Packham, J. R. & Verwijst, N. 1987: Tree population dynamics, stand structure and species composition in the montane virgin forest of Vallibäcken, Notrhern Sweden. Vegetatio 72: 3–19

Ingelög, T., Thor, G. & Gustafsson, L. 1987: Floravård i skogsbrudet. 2nd ed. Skoggtyrelsen. Jönköping.

Ivanter, E. & Kuznetsov, O. 1995: Red Data Book of Karelia. – Petrozavodsk. 286 pp. (In Russian)

Jalas, J. 1947: Kangasajuruohon (*Thymus serpyllum* L., Fr.) pohjosmaisista muodoista – Luonnon Tutkija 3: 86–92.

Jalas, J. 1948: Kylien Kasvistosta Repolan piirikunnassa Länsi–Pomorian (Kpoc) lounaiskolkassa – Acta Soc. F. Fl. Fenn. 66(3): 58 p.

Jalas, J. 1950: Zur Kausalanalyse der Verbreitung Einiger Nordischen Os–und Sandpflanzen – Ann. Bot. Fenn. 24(1): 1–365.

Jonsson, B. G. & Esseen, P. A. 1990: Treefall disturbance maintains high bryophyte diversity in boreal forests – J. Ecol. 78: 924–936.

Kaila, L., Martikainen, P., Punttila, P. & Yakovlev, E. 1994: Saproxylic beetles (Coleoptera) on dead birch trunks decayed by different polypore species – Ann. Zool. Fenn. 31: 97–108.

Konstantinova, N. A. & Vasiljev, A. N. 1994: On the hepatic flora of the Sayan Mountains (Southern Siberia) – Arctoa 3:123–133.

Konstantinova, N. A., Potemkin, A. D. & Schljakov, R. N. 1992: Checklist of Hepaticae and Anthocerotae of the former USSR – Arctoa 1: 87–127.

Kotilainen, M. 1944: Uber Flora und Vegetation der basischen Felsen im östlichen Fennoskandien. Floristische, ökologische und soziologische Studie. I. – Ann. Bot. Soc. Fenn. Vanamo. 20(1): 1–199.

Kotiranta, H., Niemelä, T. 1996: Threatened polypores in Finland. Water and Envir. Adm. Ser. B 17: 116 pp.

Kotiranta, H., Uotila, P., Sulkava, S. & Peltonen, S-L. (eds.) 1998: Red Data Book of East Fennoscandia. 351 pp. Helsinki.

Kravchenko, A. V. 1995: Flora of Nuorunen Fell and its surroundings. – In: Systra, Y. J. & Shustov, Y. A. (eds.). Nature and ecosystems of Paanajärvi National Park. Petrozavodsk. 21-33. (In Russian with English summary)

Kravchenko, A. V. 1997: Vascular plants of the Kostomuksha Nature Reserve – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.). Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve Friendship 124: 87–98. Helsinki.

Kravchenko, A. V. 1998: Influence of clear felling on some local floras of the Baltic–White Sea watershed. – In: Ecology of boreal forests. Proc. Int. Conf., 14–18 September 1998, Syktyvkar. 185-186.

Kravchenko, A. V., Gnatyuk, E. P., Butskikh, O. A., Kashtanov, M. V. & Kryshen, A. M. On the flora of vascular plants of the proposed Tulos National Park. – In: Kravchenko, A.V. et al. (eds.). Flora and fauna of the nature protected territories of Karelia Petrozavodsk. 1: 124–143. (In Russian with English summary)

Kravchenko, A. V. & Kuznetzov, O. L. 1995: Condition and distribution in Karelia of the higher vascular plant species included in the Red Data Book of Russia. – In.: Belousova, N. A. et al. (eds.), Floristic Research in Karelia Petrozavodsk. 2: 20-42. (In Russian with English summary)

Kravchenko, A. V., Romanov, G. E., Timofeeva, V. V. 1998: Using higher vascular plants as indicators of old growth forest (Matrosy training forestry unit, Karelia). – In: Bioindication – 98. Proc. Int. Seminar, 21–28 September 1998, Petrozavodsk. pp. 46–49. (In Russian & English)

Kuusinen, M. 1996: Epiphytic lichen flora and diversity in old growth boreal forests of Finland – Publications in Botany from the University of Helsinki. 23: 1–29.

Kuusinen, M., Jääskeläinen, K., & Kivistö, L. 1995: Indikaattorijäkälien kartoitus Kainuussa. Metsähallituksen Luonnonsuojelujulkaisuja A 27 pp.

Lindberg, S. O. 1879: Musci Scandinavici in Sistemate Novo Naturali Dispositi. 50 pp. Upsaliae.

Mannerkorpi, P. 1944: Uhtuan taistelurintamalle saapunesta tulokaskasveista – Ann. Bot. Soc. Zool.–Bot. Fenn. "Vanamo" 20 (5):39–51.

Mela, A. J. & Cajander, A. K. 1906: Suomen kasvio. – Helsinki. X+ 68+ 764 pp.

Nylander, W. 1852: Collectanea in Floram Karelicam – Not. Sällsk. F. et Fl. Fenn. Förh. 2:109–201.

Nylander, W. & Saelan, Th. 1859: Herbarium Musei Fennici. Fortecking afver finska musei växtsamling. 118 pp. Helsingfors.

Ovaskainen, O. (ed.). 1998: Survey of old growth forests in north–western Russia. Finnish Nature League publ. 1: 100 pp. + 5 maps.

Pyykkö, J. (ed.) 1996: Survey of the Russian Karelian natural forests of Vienansalo. WWF Finland.

Rassadina, K. A. 1950: Cetraria in the USSR – Comm. Bot. Inst. Ser. 2. Cryptogams. 5: 171–304. St. Petersburg. (In Russian).

Rassi, P. & Väisänen, R. 1987: Threatened animals and plants in Finland. – Helsinki. 82 pp.

Ramenskaya, M. L. 1983: Analysis of the flora of the Murmansk region and Karelia. – Leningrad. 216 pp. (In Russian)

Rose, F. 1976: Lichenogical indicators of age and environmental continuity in woodland. – In: Brown, D. H., Hawksworth, D. L. & Bailey, R. H. (eds.) Lichenology: progress and problems. 279–307. London.

Savicz, L. I. & Ladyzhenskaya, K. I. 1936: Manual of liverworts of the European north of the USSR. 309 pp. Moscow – Leningrad. (In Russian)

Sazonov, S. V. & Kravchenko, A. V. 1996: Establishment of a network of protected nature territories in the border zone of Karelia and Finland – Oulanka Reports 16: 115–120.

Schljakov, R. N. 1976, 1979, 1980, 1981, 1982: Liverworts of the North of the USSR, I–V. I: 91pp. II: 192 pp. III: 190 pp. IV: 221 pp. V: 196 pp. Leningrad. (In Russian).

Siitonen, J. 1994: Decaying wood and saproxylic Coleoptera in two spruce forests: a comparison based on two sampling methods – Ann. Zool. Fenn. 31: 89–95.

Söderström, L. 1988: The occurrence of epixylic bryophyte and lichen species in old natural and in managed forest stands in northern Sweden – Biol. Cons. 45: 169–178.

Söyrinki, N. 1956: Kasvistosta Oulankajoen – Pääjärven alueella Kieretin Karjalassa – Annal. Bot. Soc. Zool.– Bot. Fenn. "Vanamo" 2: 118.

Tonteri, T. 1994: Species richness of boreal forest vegetation in relation to site type and successional factors – Ann. Zool. Fenn. 31: 53–60.

Ulvinen, T., Ohenoja, E., Ahti, T. & Alanko, P. 1981: A check–list of the fungi (incl. lichens) of the Koillismaa (Kuusamo) biological province, N. E. Finland – Oulanka Reports. 2: 1–64.

Wainio, E. A. 1878: Kasvistonsuhteista Pohjois–Suomen ja Venäjän–Karjalan rajaseuduilla. 160+LVII. Helsinki.

Wainio, E. A. 1881, 1883: Adjumenta ad Lichenographiam Lapponiae atque Fenniae borealis. I, II – Medd. Soc. F. Fl. Fenn. 6: 77–182, 10: 1–230.

Vainio, E. A. 1921, 1922, 1927, 1934: Lichenographia Fennica. I–IV – Acta Soc. F. Fl. Fenn. 49(2): 1–274; 53(1): 1–340; 57(1): 1–138; 57(2): 1–506.

Virkkala, R. 1987: Effects of management on birds breeding in northern Finland – Ann. Zool. Fenn. 24: 281–294.

Vitikainen, O., Ahti, T., Kuusinen, M., Lommi, S. & Ulvinen, T. 1997: Checklist of lichens and allied fungi in Finland – Norrlinia 6: 123 pp. Helsinki.

Yakovlev, F. S. & Voronova, V. S. 1959: Forest types of Karelia and their natural division. Petrozavodsk. 190 pp. (In Russian)
Vekhov, V. N. & Bogdanova, N. E. 1971: Flora of the White Sea biological station of Moscow University – Comm. Bot. Gard. Moskow Univ. 7: 5–34. (In Russian)
Zinzerling, Yu. D. 1925: New data on the distribution of some species of eastern origin in the Leningrad district – Comm. Centr. Bot. Garden USSR 24: 176–182. (In Russian)

Appendix I

List of vascular plant species found in Kalevala research area. Abbreviations of the localities given according to the text.

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Woodsia ilvensis						+	
Athyrium filix-femina		+	+	+	+	+	+
Cystopteris fragilis	+	+					+
Diplazium sibiricum		+					
Gymnocarpium dryopteris	+	+	+	+	+	+	+
Matteuccia struthiopteris			+	+			
Dryopteris carthusiana	+	+	+	+	+	+	+
Dryopteris expansa		+	+	+			+
Dryopteris filix-mas		+					
Phegopteris connectilis	+	+	+	+	+	+	+
Pteridium aquilinum		+					
Polypodium vulgare	+				+	+	
Botrychium lanceolatum			+				
Botrychium lunaria		+					+
Botrychium multifidum			+			+	
Equisetum arvense		+	+	+	+	+	+
Equisetum fluviatile	+	+	+	+	+	+	+
Equisetum hyemale							+
Equisetum palustre	+	+	+	+	+	+	+
Equisetum pratense		+	+	+			+
Equisetum sylvaticum	+	+	+	+	+	+	+
Huperzia selago	+	+	+	+	+	+	+
Diphasiastrum complanatum		+		+	+	+	+
Lycopodium annotinum	+	+	+	+	+	+	+
Lycopodium clavatum		+					+
Lycopodium dubium	+	+	+	+			
Selaginella selaginoides	+	+	+	+	+	+	+
Isoetes lacustris		+	+	+			+
Isoetes setacea		+	+	+			+
Picea x fennica	+	+	+	+	+	+	+
Picea obovata	+	+	+	+	+	+	+
Pinus sylvestris	+	+	+	+	+	+	+
Juniperus communis	+	+	+	+	+	+	+
Sparganium angustifolium		+	+	+	+	+	+
Sparganium emersum		+		+			+
Sparganium gramineum		+					
Sparganium hyperboreum		+		+			
Sparganium minimum		+		+			+
Potamogeton alpinus		+	+	+	+	+	+
Potamogeton berchtoldii		+		+		+	
Potamogeton gramineus		+	+	+	+	+	+
Potamogeton natans			+	+			
Potamogeton perfoliatus		+		+			+
Scheuchzeria palustris	+	+	+	+	+	+	+
Alisma plantago-aquatica				+	+	+	+
Agrostis borealis				+			
Agrostis canina			+	+		+	+

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Agrostis clavata				+			
Agrostis gigantea							
Agrostis stolonifera				+			
Agrostis tenuis	+	+	+	+	+	+	+
Alopecurus aequalis		+		+	+		
Alopecurus arundinaceus		+		+			
Alopecurus geniculatus		+					
Alopecurus pratensis		+		+	+		
Anthoxanthum alpinum		+				+	+
Anthoxanthum odoratum		+	+	+	+	+	
Avenella flexuosa	+	+	+	+	+	+	+
Briza media		+					
Bromopsis inermis		+					
Calamagrostis arundinacea				+			+
Calamagrostis canescens	+	+	+	+	+	+	+
Calamagrostis epigeios		+		+	+	+	+
Calamagrostis lapponica				+			
Calamagrostis neglecta	+	+	+	+	+	+	+
Calamagrostis phragmitoides	+	+	+	+	+	+	+
Dactylis glomerata		+					
Deschampsia cespitosa	+	+	+	+	+	+	+
Elymus caninus				+		+	
Elytrigia repens		+		+	+		
Festuca ovina	+	+	+	+	+	+	+
Festuca pratensis		+	+				
Festuca rubra		+	+	+	+	+	+
Glyceria fluitans		+					
Hierochloe arctica		+	+	+			+
Hordeum vulgare		+					
Melica nutans		+	+	+	+	+	+
Milium effusum		+	+	+		+	+
Molinia caerulea	+	+	+	+	+	+	+
Nardus stricta		+		+			
Phalaroides arundinacea		+	+	+	+	+	+
Phleum alpinum		+		+		+	
Phleum pratense		+		+			
Phragmites australis	+	+	+	+	+	+	+
Poa alpigena						+	
Poa annua		+	+	+	+	+	+
Poa compressa							+
Poa nemoralis		+		+			+
Poa palustris		+		+	+		+
Poa pratensis		+	+	+	+	+	+
Poa trivialis		+		+			
Baeothryon alpinum	+	+	+	+	+	+	+
Baeothryon cespitosum		+	+	+	+	+	+
Carex acuta		+	+	+	+		+
Carex aquatilis		+		+	+		+
Carex brunnescens				+	+		+
Carex buxbaumii			+	+		+	+
Carex capillaris							+

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Carex cespitosa	+	+	+	+	+	+	+
Carex chordorrhiza	+	+	+	+	+	+	+
Carex cinerea	+	+	+	+	+	+	+
Carex diandra		+		+			
Carex dioica	+	+	+	+	+		+
Carex disperma		+	+	+	+	+	+
Carex echinata	+	+	+	+	+	+	+
Carex ericetorum							+
Carex flava	+		+			+	+
Carex globularis	+	+	+	+	+	+	+
Carex juncella		+		+			
Carex lasiocarpa	+	+	+	+	+	+	+
Carex limosa	+	+	+	+	+	+	+
Carex livida		+			+		
Carex loliacea	+	+	+	+	+	+	+
Carex nigra	+	+	+	+	+	+	+
Carex ovalis		+		+		+	
Carex pallescens		+					
Carex panicea	+	+					
Carex pauciflora	+	+	+	+	+	+	+
Carex paupercula	+	+	+	+	+	+	+
Carex rhynchophysa				+		+	+
Carex rostrata	+	+	+	+	+	+	+
Carex rotundata		+					
Carex vaginata	+	+	+	+	+	+	+
Carex vesicaria	+		+				+
Eleocharis acicularis		+	+				
Eleocharis palustris					+		+
Eriophorum gracile		+	+	+	+		
Eriophorum latifolium	+	+					
Eriophorum polystachyon	+	+	+	+	+	+	+
Eriophorum scheuchzeri		+					
Eriophorum vaginatum	+	+	+	+	+	+	+
Rhynchospora alba			+	+		+	
Scirpus lacustris		+			+		
Scirpus sylvaticus		+					
Calla palustris		+		+	+		
Juncus alpino-articulatus		+		+	+		
Juncus bufonius		+		+			
Juncus bulbosus		+					
Juncus conglomeratus		+					
Juncus filiformis	+	+	+	+	+	+	+
Juncus nodulosus	+	+		+			
Juncus stygius	+	+	+	+	+		
Luzula multiflora		+	+	+	+		
Luzula pallidula		+		+		+	+
Luzula pilosa	+	+	+	+	+	+	+
Luzula sudetica		+		+			
Tofieldia pusilla	+	+					
Maianthemum bifolium	+	+	+	+	+	+	+
Paris quadrifolia		+		+		+	+

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Corallorhiza trifida	+	+	+	+	+	+	+
Dactylorhiza x ambigua		+					
Dactylohhiza cruenta		+					
Dactylohhiza curvifolia		+					
Dactylorhiza fuchsii		+					
Dactylorhiza hebridensis		+					+
Dactylorhiza incarnata		+					
Dactylohhiza x lehmanii		+					
Dactylorhiza maculata	+	+					+
Dactylohhiza psychrophila		+					
Dactylohhiza russowii		+					
Dactylohhiza sudetica		+					
Dactylorhiza traunsteineri		+					
Goodyera repens	+	+	+	+	+	+	+
Listera cordata	+	+	+	+	+	+	+
Platanthera bifolia		+	+				
Populus tremula	+	+	+	+	+	+	+
Salix aurita		+		+		+	+
Salix caprea	+	+	+	+	+	+	+
Salix cinerea		+	+	+			
Salix lapponum		+	+	+	+	+	+
Salix myrsinifolia		+	+	+	+	+	+
Salix myrtilloides	+	+		+	+	+	+
Salix pentandra					+		
Salix phylicifolia	+	+	+	+	+	+	+
Salix starkeana		+		+		+	+
Alnus incana	+	+	+	+	+	+	+
Alnus kolaensis		+		+	+		+
Betula x intermedia							
Betula nana	+	+	+	+	+	+	+
Betula pendula	+	+	+	+	+		+
Betula pubescens	+	+	+	+	+	+	+
Cannabis sativa				+			
Urtica dioica		+		+	+		
Bistorta major		+					
Bistorta vivipara		+	+	+	+	+	
Fallopia convolvulus		+		+	+		
Persicaria amphibia					+		
Persicaria lapathifolia		+		+	+		
Polygonum aviculare		+		+	+		
Rumex acetosa		+		+	+		+
Rumex acetosella		+		+	+		
Rumex confertus		+					
Rumex longifolius		+		+	+		
Chenopodium album		+			+		
Cerastium holosteoides		+	+	+	+	+	+
Cerastium arvense		+					
Dianthus superbus							+
Melandrium dioicum		+	+		+		
Moehringia trinervia							+
Oberna behen		+			+	+	

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Sagina procumbens	+	+		+			+
Spergula arvensis		+					
Stellaria calycantha		+	+	+		+	+
Stellaria x calycantha x longifolia		+					
Stellaria graminea		+	+	+	+	+	
Stellaria longifolia		+		+			
Stellaria media		+			+		
Stellaria palustris		+					
Nuphar lutea		+	+	+	+	+	+
Nuphar x spenneriana		+		+			
Nymphaea candida		+	+	+	+	+	+
Nymphaea tetragona		+	+	+	+		+
Actaea erythrocarpa				+	+		+
Aquilegia vulgaris		+					
Batrachium peltatum		+					+
Caltha palustris	+	+	+	+	+	+	+
Ranunculus acris	+	+	+	+	+		+
Ranunculus auricomus agg.		+	+		+		
Ranunculus hyperboreus							
Ranunculus lapponicus		+	+	+	+	+	+
Ranunculus repens		+	+	+	+		+
Ranunculus reptans		+	+	+	+		+
Thalictrum flavum							+
Trollius europaeus		+	+				
Arabidopsis thaliana		+			+		
Arnoracia rusticana			+				
Barbarea arcuata		+	+	+	+		
Brassica rapa		+					
Bunias orientalis		+					
Capsella bursa-pastoris		+		+	+		
Cardamine dentata				+			+
Erysimum cheiranthoides		+					
Raphanus raphanistrum		+					
Rorippa palustris		+					
Subularia aquatica			+				
Thlaspi caerulescens		+					
Drosera anglica	+	+	+	+	+	+	+
Drosera x obovata		+					
Drosera rotundifolia	+	+	+	+	+	+	+
Parnassia palustris	+	+	+	+	+	+	+
Ribes nigrum				+			
Ribes scandicum				+			+
Ribes spicatum				+			
Alchemilla baltica		+					
Alchemilla glabricaulis		+					
Alchemilla gracilis		+					
Alchemilla monticola		+		+	+		
Alchemilla subcrenata		+					
Comarum palustre	+	+	+	+	+	+	+
Filipendula ulmaria	+	+	+	+	+	+	+
Fragaria x ananassa		+					

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Geum rivale		+		+			
Malus domestica		+					
Padus avium		+		+	+		+
Potentilla crantzii							+
Potentilla erecta		+					
Potentilla intermedia		+			+		
Rosa acicularis				+			
Rosa majalis		+		+	+	+	+
Rubus arcticus	+	+	+	+	+	+	+
Rubus x castoreus				+			
Rubus chamaemorus	+	+	+	+	+	+	+
Rubus idaeus		+	+	+	+	+	+
Rubus saxatilis	+	+	+	+	+	+	+
Sorbus aucuparia	+	+	+	+	+	+	+
Sorbus gorodkowii						+	
Amoria hybrida		+					
Amoria repens		+	+	+	+		
Chrysaspis spadicea		+					
Lathyrus pratensis		+		+	+		
Trifolium pratense		+	+	+	+		
Vicia cracca		+	+	+	+	+	
Vicia sepium		+	+	+	+		
Geranium sylvaticum	+	+	+	+	+	+	+
Callitriche cophocarpa		+					
Callitriche hermaphroditica						+	+
Callitriche palustris	+	+		+	+		+
Empetrum hermaphroditum	+	+	+	+	+	+	+
Empetrum nigrum		+		+			
Impatiens noli-tangere							+
Frangula alnus	+	+	+	+	+	+	
Hypericum maculatum		+					
Viola arvensis		+					
Viola epipsila	+		+				+
Viola montana		+	+	+	+		+
Viola palustris		+	+	+			+
Viola selkirkii				+			
Viola tricolor		+			+		
Daphne mezereum		+		+	+	+	
Lytjrum salicaria				+			
Chamaenerion angustifolium	+	+	+	+	+	+	+
Circaea alpina							+
Epilobium adenocaulon					+		
Epilobium hornemannii		+	+			+	+
Epilobium palustre	+	+	+	+	+		+
Epilobium hornemannii x palustre		+					
Myriophyllum alterniflorum		+		+	+		+
Hippuris vulgaris		+		+			+
Angelica sylvestris	+	+	+	+	+	+	+
Anthriscus sylvestris		+		+	+		
Chaerophyllum prescottii		+					
Cicuta virosa		+	+	+	+		+

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Heracleum sibiricum		+					
Pimpinella saxifraga		+			+		
Thyselium palustre		+	+	+	+		+
Chamaepericlymenum suecicum	+	+	+	+	+	+	+
Moneses uniflora	+	+	+	+	+	+	+
Orthilia secunda		+	+	+	+	+	+
Pyrola chlorantha				+			+
Pyrola minor	+	+	+	+	+	+	+
Pyrola rotundifolia	+	+	+	+	+		
Andromeda polifolia	+	+	+	+	+	+	+
Arctostaphylos uva-ursi		+		+			+
Calluna vulgaris	+	+	+	+	+	+	+
Chamaedaphne calyculata	+	+	+	+	+		+
Ledum palustre	+	+	+	+	+		+
Oxycoccus microcarpus	+	+		+	+		+
Oxycoccus palustris	+	+	+	+	+	+	+
Vaccinium myrtillus	+	+	+	+	+		+
Vaccinium uliginosum	+	+	+	+	+	+	+
Vaccinium vitis-idaea	+	+	+	+	+	+	+
Androsace filiformis		+					
Lysimachia vulgaris				+			+
Naumburgia thyrsiflora	+	+	+	+	+	+	+
Trientalis europaea	+	+	+	+	+	+	+
Gentianella lingulata		+					
Menyanthes trifoliata	+	+	+	+	+	+	+
Polemonium caeruleum		+					
Myosotis arvensis		+			+		
Galeopsis bifida		+		+	+		
Galeopsis speciosa		+		+	+		
Galeopsis tetrahit		+					
Glechoma hederacea			+		+		
Mentha arvensis				+	+		+
Prunella vulgaris		+					
Scutellaria galericulata		+		+	+	+	+
Thymus subarcticus							+
Solanum tuberosum		+		+			
Euphrasia brevipila		+	+	+	+	+	
Euphrasia parviflora		+					
Linaria vulgaris		+		+			
Melampyrum pratense	+	+	+	+	+	+	+
Melampyrum sylvaticum	+	+	+	+	+	+	+
Pedicularis palustris	+		+	+	+		+
Pedicularis sceptrum-carolinum		+					
Rhinanthus minor		+	+	+	+		+
Rhinanthus serotinus		+	+	+	+		+
Veronica chamaedrys		+		+	+		
Veronica longifolia		+	+	+	+	+	+
Veronica scutellata			+	+	+		+
Veronica serpyllifolia		+		+			
Pinguicula villosa		+					
Pinguicula vulgaris		+		+			+

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Utricularia intermedia	+	+	+	+	+	+	+
Utricularia minor	+		+	+		+	
Utricularia vulgaris		+		+			+
Plantago lanceolata		+					
Plantago major		+		+	+		+
Plantago media		+					
Galium album		+	+	+	+	+	
Galium aparine							
Galium boreale		+					
Galium palustre		+	+	+	+	+	+
Galium trifidum		+		+			
Galium triflorum		+		+			+
Galium uliginosum	+		+				+
Viburnum opulus				+			
Linnaea borealis	+	+	+	+	+	+	+
Valeriana sambucifolia		+					
Knautia arvensis		+		+			
Campanula glomerata		+					
Campanula patula		+					
Campanula rotundifolia		+		+	+		+
Lobelia dortmanna		+		+			+
Achillea millefolium		+	+	+	+	+	+
Antennaria dioica		+	+	+	+	+	+
Arctium tomentosum		+		+			
Centaurea jacea		+					
Centaurea phrygia		+					
Centaurea scabiosa		+					
Cirsium heterophyllum	+	+	+	+	+	+	+
Cirsium palustre		+		+		+	
Crepis paludosa	+	+	+	+	+	+	+
Gnaphalium uliginosum				+			
Helianthus annuus		+					
Hieracium caesium		+		+			
Hieracium cespiticola		+					
Hieracium cespitosum		+		+			
Hieracium constringens		+					
Hieracium cymosum		+					
Hieracium fennoorbicans		+					
Hieracium x floribundum		+					
Hieracium laevigatum		+		+			
Hieracium linifolium		+					+
Hieracium pilosella		+					
Hieracium prolixiforme		+					
Hieracium subarctoum		+					
Hieracium umbellatum		+	+	+	+	+	+
Hieracium vailantii		+					
Hieracium vulgatum		+	+	+			+
Leontodon autumnalis		+	+				
Lepidotheca suaveolens		+		+	+		
Leucanthemum vulgare		+		+	+		
Omalotheca sylvatica		+		+	+		

Species	Locality						
	Kost.	Latv.	Korm.	Kaun.	Veneh.	Hauk.	Kokko
Petasites frigidus						+	
Ptarmica vulgaris		+				+	
Senecio vulgaris				+			
Solidago lapponica						+	
Solidago virgauera	+	+	+	+	+	+	+
Tanacetum vulgare		+			+		
Taraxacum officinale		+	+	+	+	+	+
Tripleurospermum perforatum		+					
Tussilago farfara		+		+			

Appendix 2

List of vascular plant species found in Paanajarvi area. Abbreviations of the localities given according to the text.

Species	Localities														
	Regio Kuusamoensis									*Karelia keretina*					
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh
Woodsia x alpina			+	+											
Woodsia x gracilis	+		+												
Athyrium filix-femina										+	+	+		+	+
Cystopteris fragilis	+	+	+							+	+			+	
Diplazium sibiricum						+						+			
Gymnocarpium dryopteris	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhizomatopteris montana	+	+	+								+	+			
Matteuccia struthiopteris			+			+								+	+
Dryopteris carthusiana	+				+	+		+		+		+		+	+
Dryopteris expansa		+										+		+	
Phegopteris connectilis		+	+		+	+	+			+		+		+	+
Pteridium aquilinum						+									
Polypodium vulgare	+		+				+								
Botrychium lanceolatum	+														
Botrychium lunaria			+												
Botrychium multifidum	+														
Equisetum arvense	+		+			+							+	+	+
Equisetum fluviatile	+		+		+	+	+	+	+	+	+	+	+	+	+
Equisetum hyemale	+		+							+		+			
Equisetum x litorale		+													
Equisetum palustre	+	+	+		+	+		+		+		+		+	
Equisetum pratense	+	+	+			+		+				+		+	+
Equisetum scirpoides	+	+	+												+
Equisetum sylvaticum	+	+	+		+	+	+	+	+	+	+	+	+	+	+
Equisetum variegatum	+	+	+			+						+			
Huperzia selago	+	+	+		+			+		+	+				
Diphasiastrum alpinum					+			+			+				
Diphasiastrum complanatum			+		+										
Lycopodium annotinum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lycopodium dubium	+									+					

Species	*Regio Kuusamoensis*								*Karelia keretina*							
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh	
Lycopodium lagopus					+			+								
Selaginella selaginoides	+	+	+		+	+				+						
Isoetes setacea														+		
Picea x fennica	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Picea obovata			+		+						+			+	+	
Pinus sylvestris	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Juniperus communis					+	+				+				+	+	
Juniperus sibirica			+		+			+			+					
Sparganium angustifolium															+	
Sparganium emersum															+	
Sparganium gramineum	+															
Sparganium hyperboreum										+					+	
Sparganium minimum		+				+								+		
Potamogeton alpinus		+	+		+		+		+	+		+	+	+	+	
Potamogeton gramineus			+		+		+	+	+			+		+	+	
Potamogeton natans																
Potamogeton perfoliatus	+					+								+		
Potamogeton praelongus																
Scheuchzeria palustris					+									+		
Triglochin palustre		+													+	
Agrostis borealis		+														
Agrostis canina		+												+	+	
Agrostis tenuis	+		+		+	+				+				+	+	
Alopecurus aequalis	+						+							+	+	
Alopecurus arundinaceus			+			+	+									
Alopecurus pratensis			+													
Anthoxanthum alpinum	+	+	+		+		+			+		+		+	+	
Anthoxanthum odoratum														+		
Avenella flexuosa			+		+	+	+	+	+	+	+	+	+	+	+	
Calamagrostis canescens					+	+			+			+	+	+	+	
Calamagrostis epigeios	+		+			+				+					+	
Calamagrostis lapponica	+	+	+				+			+						
Calamagrostis neglecta	+					+		+			+	+	+	+		
Calamagrostis phragmitoides	+	+	+		+	+	+	+	+	+	+	+	+	+	+	
Dactylis glomerata						+									+	
Deschampsia cespitosa	+	+	+		+	+	+	+	+	+	+	+	+	+	+	
Elymus caninus		+	+			+			+			+			+	
Elytrigia repens	+		'+			+	+					+		+		
Festuca ovina			+		+	+		+		+	+	+		+	+	
Festuca pratensis												+				
Festuca rubra	+	+	+			+	+		+			+		+	+	
Helictotrichon pubescens							+									
Hierochloe arctica	+	+	+							+						
Melica nutans		+	+		+	+	+			+		+		+	+	
Milium effusum		+	+		+	+	+					+		+	+	
Molinia caerulea	+				+	+	+	+	+	+	+	+	+	+	+	
Nardus stricta					+									+	+	
Phalaroides arundinacea		+	+		+	+			+	+				+	+	
Phleum alpinum	+	+	+		+		+							+		
Phleum pratense	+		+			+										

Species	*Regio Kuusamoensis* Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	*Karelia keretina* Tav	Pää	Silt	Lep	Oht	Tuh
Phragmites australis	+				+									+	+
Poa alpigena		+	+												
Poa annua	+					+	+			+				+	+
Poa compressa															+
Poa glauca		+	+												
Poa nemoralis			+		+							+		+	+
Poa palustris					+	+	+					+		+	+
Poa pratensis	+		+											+	+
Poa tanfiljewii			+												
Poa trivialis		+													+
Baeothryon alpinum	+	+	+		+	+	+			+			+	+	
Baeothryon cespitosum	+		+		+					+					
Carex acuta			+		+	+	+					+		+	+
Carex adelostoma	+				+			+							
Carex aquatilis			+		+							+		+	
Carex atherodes			+												
Carex brunnescens					+	+		+			+			+	+
Carex buxbaumii	+	+			+	+				+					
Carex capillaris	+	+	+							+		+			
Carex capitata	+		+												
Carex cespitosa	+	+	+		+	+	+			+		+		+	+
Carex chordorrhiza	+	+	+	+	+	+		+	+	+	+	+	+	+	+
Carex cinerea	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carex diandra	+						+								
Carex digitata												+			
Carex dioica	+	+	+		+					+			+	+	
Carex disperma					+		+					+	+	+	+
Carex echinata										+			+	+	
Carex flava	+	+				+			+	+		+			
Carex globularis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carex juncella	+		+											+	
Carex lasiocarpa			+		+	+		+		+		+	+	+	+
Carex limosa	+		+		+	+		+	+	+	+	+	+	+	
Carex livida														+	
Carex loliacea	+	+	+	+			+			+		+	+	+	+
Carex media	+		+		+	+	+	+		+					
Carex nigra	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Carex ovalis													+		+
Carex pallescens						+									
Carex panicea	+					+									
Carex pauciflora		+			+						+		+	+	+
Carex paupercula			+		+	+	+	+	+	+	+	+	+	+	+
Carex rhynchophysa							+								
Carex rostrata	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carex vaginata	+	+	+		+	+		+		+		+		+	+
Carex vesicaria	+					+				+		+		+	
Eleocharis acicularis	+														
Eleocharis palustris	+										+			+	
Eleocharis quinqueflora		+													
Eriophorum brachyantherum	+	+	+												

Species	*Regio Kuusamoensis*									*Karelia keretina*					
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh
Eriophorum gracile													+		
Eriophorum latifolium	+	+	+							+					
Eriophorum polystachyon	+	+	+		+	+		+		+		+	+	+	+
Eriophorum scheuchzeri	+	+	?+				+								
Eriophorum vaginatum	+	+	+		+			+		+	+		+	+	+
Rhynchospora alba															
Schoenus ferrugineus		+													
Juncus alpino-articulatus	+		+	+										+	+
Juncus bufonius	+					+	+								+
Juncus filiformis		+	+		+	+	+			+				+	+
Juncus nodulosus							+								
Juncus stygius					+										
Juncus trifidus					+			+			+				
Luzula multiflora	+					+								+	+
Luzula pallidula			+			+									
Luzula pilosa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Luzula sudetica		+	+		+		+								
Tofieldia pusilla	+	+	+		+	+				+				+	
Convallaria majalis									+		+				
Maianthemum bifolium	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Paris quadrifolia	+	+	+	+		+	+			+		+		+	+
Cypripedium calceolus			+			+									
Calypso bulbosa						+						+			
Coeloglossum viride	+	+	+				+								
Corallorhiza trifida			+		+		+			+		+		+	+
Dactylorhiza hebridensis	+	+	+				+								
Dactylorhiza incarnata	+	+						+						+	
Dactylorhiza maculata		+	+		+					+	+		+	+	+
Dactylorhiza traunsteineri	+									+				+	
Goodyera repens		+										+	+	+	
Gymnadenia conopsea		+	+		+										
Listera cordata	+	+	+		+		+				+			+	+
Listera ovata		+													
Populus tremula	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Salix bebbiana		+													
Salix caprea			+		+	+	+	+	+	+	+	+	+	+	+
Salix glauca		+	+		+			+			+				
Salix hastata		+				+						+			
Salix lanata		+	+			+									
Salix lapponum			+		+	+				+				+	+
Salix myrsinifolia	+	+	+			+	+					+			+
Salix myrsinites	+	+	+							+					
Salix myrtilloides		+								+			+		
Salix pentandra	+		+												
Salix phylicifolia			+		+	+		+		+	+	+		+	+
Salix starkeana													+	+	
Alnus incana	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Alnus kolaensis			+		+					+		+		+	+
Betula nana	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Betula nana x pendula			+												

Species	*Regio Kuusamoensis*									*Karelia keretina*					
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh
Betula pendula	+	+												+	
Betula pubescens	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Betula subarctica					+										
Betula chrepanowii					+										
Urtica dioica			+				+							+	+
Urtica sondenii	+					+									
Bistorta vivipara	+	+	+			+	+					+		+	+
Polygonum aviculare		+												+	+
Rumex acetosa	+		+			+	+							+	+
Rumex acetosella	+					+	+		+					+	+
Rumex aquaticus			+									+			+
Rumex longifolius	+	+				+								+	+
Chenopodium album														+	
Montia fontana		+	+											+	
Cerastium holosteoides	+	+	+			+	+					+		+	+
Cerastium scandicum			+												
Coccyganthe flos-cuculi							+								
Dianthus superbus	+		+				+					+			
Melandrium dioicum	+		+				+							+	
Oberna behen			+				+							+	
Silene tatarica	+					+									
Stellaria calycantha		+	+								+			+	+
Stellaria x calycantha x longifolia			+												
Stellaria crassifolia		+													
Stellaria fennica							+								
Stellaria graminea	+		+			+	+					+	+	+	+
Stellaria longifolia			+									+			
Stellaria media	+														
Steris alpina										+					
Nuphar lutea					+	+	+							+	+
Nymphaea candida		+										+			+
Actaea erythrocarpa	+	+	+			+			+					+	
Batrachium eradicatum			+												
Batrachium peltatum	+		+			+	+					+		+	+
Caltha palustris	+		+		+	+	+			+		+		+	+
Ranunculus acris	+	+	+		+	+	+					+		+	+
Ranunculus acris x subborealis			+				+								
Ranunculus auricomus agg.	+		+			+	+					+		+	+
Ranunculus lapponicus													+		
Ranunculus propinquus													+		
Ranunculus repens	+				+	+	+					+		+	+
Ranunculus reptans			+			+						+		+	
Thalictrum flavum	+	+	+			+			+	+		+		+	+
Thalictrum rariflorum								+		+					
Trollius europaeus	+	+	+	+	+		+			+	+	+			
Arabis alpina			+												
Barbarea stricta						+									
Barbarea arcuata	+		+											+	
Capsella bursa-pastoris	+														+
Cardamine dentata	+		+			+	+							+	+

Species	*Regio Kuusamoensis*							*Karelia keretina*							
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh
Cardamine nymanii						+									
Cardaminopsis arenosa	+					+						+	+		
Thlaspi arvense			+												
Drosera anglica	+				+			+	+	+			+	+	
Drosera rotundifolia	+				+					+	+		+	+	+
Saxifraga nivalis			+							+				+	
Parnassia palustris	+	+	+		+		+			+	+	+		+	
Ribes acidum	+		+			+									
Ribes nigrum							+								+
Ribes scandicum							+					+			
Ribes spicatum												+		+	+
Alchemilla glomerulans		+	+			+						+			
Alchemilla monticola						+								+	+
Comarum palustre					+	+	+			+		+		+	+
Filipendula ulmaria	+	+	+	+	+	+	+			+	+	+		+	+
Fragaria vesca			+												
Geum rivale		+	+		+		+			+		+		+	+
Padus avium	+	+	+			+	+			+		+		+	+
Potentilla crantzii										+					
Potentilla erecta	+	+	+		+	+				+					
Potentilla intermedia						+									
Rosa majalis	+		+		+	+			+			+		+	+
Rubus arcticus	+				+			+			+	+		+	+
Rubus x castoreus							+								+
Rubus chamaemorus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rubus idaeus			+		+	+	+		+		+	+		+	+
Rubus saxatilis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sorbus aucuparia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sorbus gorodkowii								+							
Amoria repens	+		+			+	+					+		+	
Astragalus frigidus		+	+			+	+					+			
Astragalus subpolaris	+	+	+									+			
Lathyrus palustris	+					+									
Lathyrus pratensis			+			+	+							+	
Lathyrus vernus											+				
Oxytropis sordida	+	+	+			+									
Trifolium pratense	+	+	+											+	
Vicia cracca			+			+	+							+	+
Vicia sepium	+		+			+						+		+	+
Vicia sylvatica	+					+	+			+	+				
Geranium pratense			+												
Geranium sylvaticum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Polygala amarella									+						
Callitriche palustris	+						+							+	+
Empetrum hermaphroditum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Empetrum nigrum								+						+	
Frangula alnus		+			+					+				+	+
Hypericum maculatum							+								
Viola arvensis							+								
Viola epipsila	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Species	*Regio Kuusamoensis*								*Karelia keretina*							
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh	
Viola epipsiloides						+										
Viola montana		+	+			+			+	+		+		+		
Viola palustris	+		+				+							+		
Viola rupestris			+				+									
Viola selkirkii			+	+												
Daphne mezereum			+				+				+					
Chamaenerion angustifolium	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Circaea alpina			+													
Epilobium alsinifolium		+														
Epilobium davuricum	+	+	+													
Epilobium hornemannii		+	+		+						+			+	+	
Epilobium palustre		+	+			+		+			+			+		
Epilobium x hornemanii x palustre			+													
Myriophyllum alterniflorum	+		+		+	+			+			+		+		
Myriophyllum sibiricum	+															
Hippuris vulgaris	+		+			+	+					+		+		
Angelica archangelica			+				+					+				
Angelica sylvestris	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Anthriscus sylvestris	+		+			+	+				+			+		
Chaerophyllum prescottii	+		+				+									
Cicuta virosa												+		+		
Heracleum sibiricum			+													
Chamaepericlymenum suecicum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Moneses uniflora	+	+	+				+					+	+	+		
Orthilia secunda	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Pyrola chlorantha												+				
Pyrola media						+										
Pyrola minor	+	+	+		+	+	+	+		+	+	+	+	+		
Pyrola norvegica								+								
Pyrola rotundifolia	+	+	+			+	+					+		+		
Andromeda polifolia	+	+	+	+	+						+		+	+	+	
Arctostaphylos uva-ursi			+									+		+		
Arctous alpina					+			+			+					
Calluna vulgaris								+			+			+	+	
Chamaedaphne calyculata	+				+									+		
Ledum palustre	+		+			+		+	+	+	+	+	+	+	+	
Loiseleuria procumbens					+			+			+					
Oxycoccus microcarpus	+				+									+		
Oxycoccus palustris	+				+	+	+	+	+	+	+	+	+	+	+	
Phyllodoce caerulea					+			+			+					
Vaccinium myrtillus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Vaccinium uliginosum	+					+					+			+	+	
Vaccinium vitis-idaea	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Naumburgia thyrsiflora	+				+	+	+	+	+	+	+	+	+	+	+	
Trientalis europaea	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Menyanthes trifoliata			+		+	+	+	+	+	+	+	+	+	+	+	
Myosotis arvensis			+			+										
Myosotis cespitosa	+	+										+				
Symphytum officinale						+										
Galeopsis bifida			+			+	+							+		

Species	*Regio Kuusamoensis*							*Karelia keretina*							
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh
Galeopsis speciosa			+			+	+								
Mentha arvensis			+		+	+	+					+		+	
Prunella vulgaris			+			+	+							+	+
Scutellaria galericulata	+	+			+	+	+					+		+	
Thymus serpyllum			+								+				
Thymus subarcticus	+		+			+						+			
Bartsia alpina	+	+	+		+	+		+		+		+			
Euphrasia brevipila	+						+							+	+
Euphrasia frigida					+	+				+		+			
Melampyrum pratense					+	+	+	+	+	+	+	+	+	+	+
Melampyrum sylvaticum	+	+	+			+		+		+	+	+		+	+
Pedicularis palustris	+	+	+		+								+	+	
Pedicularis sceptrum-carolinum	+	+				+	+			+		+			
Rhinanthus minor	+					+	+							+	
Rhinanthus serotinus	+		+			+	+							+	
Veronica chamaedrys						+	+							+	
Veronica longifolia	+		+		+	+						+		+	
Veronica scutellata							+					+		+	
Veronica serpyllifolia	+		+			+	+					+		+	+
Pinguicula alpina	+	+	+									+			
Pinguicula vulgaris	+	+	+		+	+		+		+				+	
Utricularia intermedia						+								+	
Utricularia minor						+									
Utricularia vulgaris													+	+	+
Plantago major	+					+	+								
Plantago media							+								
Galium album			+			+	+							+	+
Galium boreale	+	+	+		+	+	+					+			+
Galium palustre	+	+			+	+	+		+	+		+		+	
Galium triflorum														+	
Galium uliginosum		+	+		+	+	+			+				+	+
Viburnum opulus										+					
Linnaea borealis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lonicera pallasii	+					+	+					+			
Campanula rotundifolia	+	+	+		+	+			+	+		+		+	+
Achillea millefolium			+			+	+					+		+	+
Antennaria dioica	+		+		+	+		+		+	+	+		+	
Artemisia absinthium							+								
Carduus crispus			+			+	+								
Centaurea phrygia						+									
Cicerbita alpina					+		+	+		+	+	+			
Cirsium heterophyllum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cirsium palustre														+	
Cirsium setosum			+			+	+								
Crepis paludosa	+	+	+		+	+	+			+		+			+
Erigeron acris	+														
Hieracium cespitosum, coll.			+				+							+	
Hieracium lateriflorum											+				
Hieracium pilosella	+													+	
Hieracium subpellucidum													+		

Species	*Regio Kuusamoensis*										*Karelia keretina*				
	Lep	Loh	Män	Sel	Uko	Oul	Var	Kiv	Han	Tav	Pää	Silt	Lep	Oht	Tuh
Hieracium umbellatum	+		+			+	+			+		+		+	
Hieracium vulgatum, coll.	+	+	+			+	+	+	+	+	+	+	+	+	+
Inula salicina			+			+									
Lactuca sibirica			+												
Leontodon autumnalis						+	+							+	+
Lepidotheca suaveolens	+					+	+								
Leucanthemum vulgare			+			+	+								
Omalotheca norvegica					+						+				
Omalotheca sylvatica						+								+	
Petasites frigidus			+				+						+	+	
Saussurea alpina	+	+	+			+	+			+		+			
Solidago virgauera	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tanacetum vulgare	+		+			+	+					+			
Taraxacum officinale			+									+		+	+
Tripleurospermum perforatum														+	
Tripleurospermum subpolare	+														

Appendix 3

The list of hepatics found in research area. Species marked with asterisk were collected in old-growth forests. Names of localities are given in the text.

Species	Localities								
	1	2	3	4	5	6	7	8	9
1. Aneura pinguis (L.) Dum.	I	I	I			I			
2. Anthelia juratzkana (Limpr.) Trev.				I			I		
3. *Barbilophzia barbata (Schmid. ex Schreb.) Loeske	I	I	I	I	I	I	I	I	I
4. *B. hatcheri (Evans.) Loeske		I		I	I	I	I	I	
5. *B. lycopodioides (Wallr.) Loeske	I	I	I	I	I	I	I	I	I
6. Blasia pusilla L.	I					I		I	
7. Blepharostoma trichophyllum (L.) Dum.	I	I	I	I	I	I	I	I	I
8. *Calypogeia integristipula Steph.		I	I		I	I			
9. *C. muelleriana (Schiffn.) K.Muell.		I		I					I
10. C. sphagnicola (H.Arn. & J.Perss.) Warnst. & Loeske	I	I	I			I	I	I	
11. *Cephalozia bicuspidata (L.) Dum.	I	I	I	I	I	I		I	
12. *C. leucantha Spruce	I	I	I	I				I	
13. *C. loitlesbergeri Schiffn.		I							
14. C. lunulifolia (Dum.) Dum.	I	I			I	I	I		
15. C. pleniceps (Aust.) Lindb.				I					
16. Cephaloziella cf. arctogena (Schust.) Konst.						I			
17. *C. divaricata (Sm.) Schiffn.						I			
18. C. cf. hampeana (Nees) Schiffn.		I							

Species	Localities								
	1	2	3	4	5	6	7	8	9
19. C. rubella (Nees) Warnst.	I								
20. *Chiloscyphus polyanthos (L.) Corda		I						I	
21. *Cladopodiella fluitans (Nees) Buch	I	I	I		I	I		I	
22. *Conocephalum conicum (L.) Und.		I			I			I	
23. *Crossocalyx hellerianus (Nees ex Lindenb.) Meyl		I	I			I			I
24. Diplophyllum taxifolium (Wahlenb.) Dum.		I		I	I		I		
25. Fossombronia sp.		I							
26. *Gymnocolea inflata	I	I		I			I	I	
27. Gymnomitroin concinnatum (Lightf.) Corda				I			I		
28. *Harpanthus flotovianus (Nees) Nees	I	I	I			I	I		I
29. Isopaches bicrenatus (Schmid. ex Hoffm.) Buch	I								
30. Jungermannia boralis Damsh. et Vana		I							
31. *Leiocolea gillmanii (Aust.) Evans			I				I		
32. *L. heterocolpos (Thed. ex Hartm.) Buch		I		I					
33. *Lepidozia reptans (L.) Dum.	I	I	I	I	I	I	I	I	I
34. *Lophocolea heterophylla (Schrad.) Dum.									I
35. *L. minor Nees								I	
36. *Lophozia ascedens (Warnst.) Schust.			I						
37. *L. confertifolia Schiffn.		I	I			I			
38. L. jurensis Meyl. ex K.Muell.								I	
39. *L. longidens (Lindb.) Macoun		I	I	I	I	I	I	I	I
40. *L. longiflora (Nees) Schiffn.	I	I	I	I	I	I	I	I	I
41. L. rufescens Schljak.				I			I		
42. *L. ventricosa (Dicks.) Dum.	I	I	I	I	I	I	I	I	I
43. L. wenzelii (Nees) Steph.		I		I	I			I	
44. *Marchantia alpestris (Nees) Burgeff.								I	
45. *M. polymorpha L.		I	I		I	I		I	
46. Marsupela aquatica (Lindenb.) Schiffn.		I		I					
47. Mylia anomala (Hook.) S.Gray	I	I	I	I	I	I	I	I	
48. Nardia geocyphus (De Not) Lindb.						I			
49. N. insecta Lindb.		I			I			I	
50. N. scalaris S.Gray						I	I		
51. Odontoshisma elongatum (Lindb.) Evans	I	I	I	I					
52. *Orthocaulis attenuatus (Mart.) Evans		I	I	I	I	I		I	I
53. O. binsteadii (Kaal) Buch				I					
54. *O. kunzeanus (Hueb.) Buch	I	I	I	I		I			
55. Pellia epiphylla (L.) Corda	I								
56. P. neesiana (Gott.) Limpr.	I	I	I	I	I	I	I	I	I
57. *Plagiochila major (Nees) S.Arnell					I				
58. *P. porelloides (Torrey ex Nees) Lindenb.	I		I		I			I	
59. Plectocolea hyalina (Lyell.) Mitt.				I					
60. P. obovata (Nees) Lindb.	I	I	I	I	I				I
61. Preissia quadrata (Scop.) Nees		I	I		I				
62. *Ptilidium ciliare (L.) Hampe	I	I	I	I	I	I	I	I	I
63. *P. pulcherrimum (G.Web.) Vain.	I	I	I	I	I	I	I	I	I
64. *Riccardia latifrons (Lindb.) Lindb.	I								
65. R. multifida (L.) S.Gray	I								
66. R. palmata (Hadw.) Carruth.			I						
67. Scapania hyperborea Joerg.							I		
68. *S. irrigua (Nees) Nees	I	I	I		I		I		

Species	Localities								
	1	2	3	4	5	6	7	8	9
69. *S. mucronata Buch		I	I			I			
70. *S. paludicola Loeske et K.Muell.	I		I	I	I	I		I	
71. *S. praetervisa Meyl.			I		I		I		
72. S. scandica (H.Arnell. et Buch) Macv.	I	I	I					I	
73. *S. undulata (L.) Dum.	I	I	I	I	I	I	I		
74. *Schistochilopsis incisa (Schrad.) Konst.		I	I					I	
75. Solenostoma caespiticium (Lindenb.) Steth.					I	I			
76. S. confertissimum (Nees) Schljak.	I					I		I	
77. S.sphaerocarpum (Hook) Steph.						I			
78. *Sphenolobus minutus (Schreb.) Berggr.	I	I	I	I	I	I	I	I	
79. *S. saxicola (Schrad.) Steph.	I		I	I	I		I	I	
80. *Tetralophozia setiformis (Ehrh.) Schljak.		I		I	I		I		
81. *Tritomaria quinquedentata (Huds.) Buch	I	I	I	I	I	I	I	I	
82. *T. scitula (Tayl.) Joerg.								I	

Appendix 4.

List of lichen taxa of Kostomuksha and Kalevala study areas

Species	Localities			
	Kiitehenjärvi	Kostamus	Kaunisjärvi	Sudnozero
1. Arthonia incarnata Th.Fr. ex Almq.			+	
2. Arthonia radiata (Pers.) Ach.	+			
3. Chrysothrix chlorina (Ach.) J.R.Laundon	+			
4. Calicium glaucellum Ach.	+			
5. Calicium trabinellum (Ach.) Ach.	+			
6. Calicium viride Pers.	+			
7. Chaenotheca chrysocephala (Turner ex Ach.) Th.Fr.	+			
8. Chaenotheca ferruginea (Turner & Borrer) Mig.		+		
9. Xylographa parallela (Ach.: Fr.) Behlen & Desberg			+	
10. Alectoria sarmentosa (Ach.) Ach.	+	+	+	+
11. Biatora efflorescens(Hedl.) Räsänen			+	
12. Cliostomum leprosum (Räsänen)Holien & Tønsberg			+	
13. Candelariella vitellina(Hoffm.)Müll. Arg.	+			+
14. Hypocenomyce scalaris (Ach.) Choisy	+	+	+	+
15. Cladina arbuscula (Wallr.) Hale & W.L.Culb. s.lat.	+	+	+	+
16. C. mitis (Sandst.) Hustish	+	+	+	+
17. C. stellaris (Opiz)Brodo	+	+	+	+
18. Cladonia amaurocraea (Flörke) Schaer.	+			
19. C. bacilliformis (Nyl.) Glück	+			+
20. C. botrytes (K.G.Hagen) Willd.	+	+	+	+
21. C. carneola (Fr.)Fr.		+		
22. C. cenotea (Ach.) Schaer.	+	+	+	+

Species	Localities Kiitehenjärvi	Kostamus	Kaunisjärvi	Sudnozero
23. C. cervicornis (Ach.)Flot. ssp. verticillata (Hoffm.)Ahti	+			+
24. C. chlorophaea (Flörke ex Sommerf.) Spreng	+	+		
25. C. coccifera (L.) Willd.			+	
26. C. coniocraea (Flörke) Spreng.	+			
27. C. cornuta (L.) Hoffm.	+	+	+	+
28. C. crispata (Ach.)Flot. s.lat.	+			
29. C. deformis (L.) Hoffm.	+	+	+	+
30. C. digitata (L.) Hoffm.	+			
31. C. fimbriata (L.) Fr.	+	+	+	+
32. C. floerkeana (Fr.)Sommerf.	+			
33. C. furcata (Huds.) Schrad.	+			+
34. C. gracilis (L.) Willd. ssp. turbinata (Ach.)Ahti	+	+	+	+
35. C. grayi G.Merr. ex Sandst.		+		
36. C. macilenta Hoffm.				+
37. C. macrophylla (Schaer.)Stenh.	+			
38. C. phyllophora Hoffm.	+			
39. C. pleurota (Flörke) Schaer.	+			
40. C. pyxidata (L.) Hoffm.		+		+
41. C. squamosa Hoffm.	+			
42. C. sulphurina (Michx) Fr.			+	+
43. C. turgida Hoffm.	+			
44. C. uncialis (L.) F.H.Wigg. s.lat.		+		+
45. Leptogium saturninum (Dick.)Nyl.	+		+	+
46. Lopadium disciforme (Flot.)Kullh.	+		+	+
47. Aspicilia cinerea (L.) Körb.	+			+
48. Lecanora allophana Nyl.				+
49. L. circumborealis Brodo & Vitik.	+	+		
50. L. fuscescens (Sommerf.) Nyl.	+			
51. L. hypopta (Ach.) Vain.	+			+
52. L. populicola (DC.) Duby	+			
53. L. pulicaris (Pers.) Ach.	+	+		
54. L. symmicta (Ach.) Ach.	+			+
55. Lecidella euphorea (Flörke)Hertel	+			
56. Micarea denigrata (Fr.)Hedl.				+
57. Micarea lignaria (Ach.) Hedl. s. lat.	+			
58. Micarea melaena (Nyl.)Hedl.		+		
59. Mycobilimbia carneoalbida (Müll.Arg.)comb. ined.	+		+	+
60. Mycobilimbia epixanthoides (Nyl.) comb. ined.	+		+	+
61. Mycobilimbia tetramera (DeNot) comb. ined	+			
62. Japewia tornoensis (Nyl.) Tønsberg		+		
63. Mycoblastus sanguinarius (L.) Norman	+	+	+	+
64. Fuscopannaria leucophaea (Vahl.)P.M.Jørg.	+			
65. Pannaria pezizoides (G.Weber)Trevis.	+		+	
66. Parmeliella triptophylla (Ach.)Müll.Arg.			+	
67. Arctoparmelia centrifuga (L.)Hale	+		+	
68. Bryoria capillaris (Ach.) Brodo & D. Hawksw.	+	+	+	+
69. Bryoria fremontii (Tuck.) Brodo & D.Hawksw.	+	+	+	+
70. Bryoria furcellata (Fr.) Brodo & D.Hawksw.	+	+	+	+
71. Bryoria fuscescens (Gyeln.) Brodo & D.Hawksw.	+	+	+	+
72. Bryoria cf. implexa (Hoffm.) Brodo & D.Hawksw.			+	

Species	Localities Kiitehenjärvi	Kostamus	Kaunisjärvi	Sudnozero
73. Bryoria lanestris (Ach.) Brodo & D.Hawksw.	+			
74. Bryoria simplicior (Vain.) Brodo & D. Hawksw.	+		+	
75. Cetraria ericetorum Opiz.	+		+	+
76. Cetraria islandica (L.) Ach. s. lat.	+		+	+
77. Cetraria sepincola (Ehrh.) Ach.	+	+	+	+
78. Evernia divaricata (L.) Ach.			+	
79. Evernia mesomorpha Nyl.	+	+	+	+
80. Evernia prunastri (L.) Ach.	+			+
81. Hypogymnia physodes (L.) Nyl.	+	+	+	+
82. Hypogymnia tubulosa (Schaer.) Hav.	+	+	+	+
83. Hypogymnia vittata (Ach.)Parrique			+	
84. Imshaugia aleurites (Ach.) S.L.F. Meyer	+	+	+	+
85. Melanelia commixta (Nyl.) Tell			+	+
86. Melanelia olivacea (L.) Essl.	+		+	+
87. Melanelia sorediata (Ach.) Goward & Ahti	+		+	+
88. Melanelia stygia (L.)Essl.	+	+	+	+
89. Melanelia subaurifera (Nyl.)Essl.			+	+
90. Parmelia saxatilis (L.) Ach.		+	+	+
91. Parmelia sulcata Taylor	+	+	+	+
92. Parmeliopsis ambigua (Wulfen) Nyl.	+	+	+	+
93. Parmeliopsis hyperopta (Ach.) Arnold	+	+	+	+
94. Platismatia glauca (L.) W.L.Culb. & C.F.Culb.	+	+	+	+
95. Pseudevernia furfuracea (L.)Zopf	+			
96. Tuckermannopsis chlorophylla (Willd.)Hale	+	+	+	+
97. Usnea filipendula Stirt.		+	+	+
98. Usnea glabrescens (Nyl.ex Vain.) Vain.	+			
99. Usnea hirta (L.) Weber ex F.H.Wigg.	+	+		+
100. Usnea lapponica Vain.		+		
101. Usnea subfloridana Stirt.	+	+		+
102. Vulpicida pinastri (Scop.) J.E.Mattsson & M.J.Lai	+	+	+	+
103. Xanthoparmelia conspersa (Ach.) Hale	+	+	+	
104. Amandinea punctata (Hoffm.) Coppins & Scheid.	+			+
105. Buellia disciformis (Fr.)Mudd				+
106. Phaeophyscia ciliata (Hoffm.)Moberg			+	+
107. Phaeophyscia orbicularis (Neck.)Moberg			+	+
108. Physcia aipolia (Ehrh. ex Humb.) Fürnr. s.lat.	+		+	+
109. Physcia stellaris (L.)Nyl.	+		+	+
110. Rinodina cf. cinereovirens (Vain.)Vain.			+	
111. Rinodina sophodes (Ach.) A.Massal.	+			+
112. Ramalina dilacerata (Hoffm.)Hoffm.	+		+	
113. Ramalina farinacea (L.) Ach.	+			
114. Rhizocarpon geographicum (L.) DC. s. lat.	+			+
115. Stereocaulon condensatum Hoffm.	+			
116. Stereocaulon dactylophyllum Flörke	+			
117. Stereocaulon cf. grande (H. Magn.) H.Magn.			+	
118. Stereocaulon paschale (L.) Hoffm.	+			
119. Stereocaulon saxatile H.Magn.	+			
120. Stereocaulon tomentosum Fr.	+			+
121. Trapeliopsis flexuosa (Fr.) Coppins & P.James	+			
122. Trapeliopsis granulosa (Hoffm.) Lumbsch.	+	+		+

Species	Localities Kiitehenjärvi	Kostamus	Kaunisjärvi	Sudnozero
123. Umbilicaria cylindrica (L.) Delise ex Duby	+			
124. Umbilicaria deusta (L.) Baumg.	+			
125. Umbilicaria hyperborea (Ach.) Hoffm.			+	+
126. Lepraria incana coll.	+	+	+	+
127. Baeomyces carneus Flörke	+		+	
128. Baeomyces placophyllus Ach.	+	+		
129. Baeomyces rufus (Huds.)Rebent.	+			+
130. Dibaeis baeomyces (L. Fil.)Rambold & Hertel	+			
131. Icmadophila ericetorum (L.)Zahlbr.	+	+	+	
132. Lobaria pulmonaria (L.) Hoffm.	+	+	+	+
133. Nephroma arcticum (L.) Torss.			+	
134. Nephroma bellum (Spreng.)Tuck.	+		+	+
135. Nephroma parile (Ach.)Ach.			+	+
136. Nephroma resupinatum (L.)Ach.	+		+	+
137. Peltigera aphthosa (L.) Willd.	+		+	+
138. Peltigera canina (L.) Willd.	+		+	+
139. Peltigera cf. degenii Gyeln.			+	
140. Peltigera didactyla (With.) J.R.Laundon	+			+
141. Peltigera leucophlebia (Nyl.)Gyeln.	+		+	
142. Peltigera malacea (Ach.) Funck	+		+	+
143. Peltigera neopolydactyla (Gyeln.)Gyeln.			+	
144. Peltigera praetextata (Sommerf.) Zopf.	+	+	+	
145. Peltigera rufescens (Weiss.) Humb.				+
146. Ochrolechia alboflavescens (Wulf.) Zahlbr.	+	+		
147. Ochrolechia androgyna (Hoffm.) Arnold	+	+	+	+
148. Ochrolechia arborea (Kreyer) Almb.	+	+		
149. Ochrolechia frigida (Sw.) Lynge	+			
150. Pertusaria amara (Ach.)Nyl.	+		+	+
151. Caloplaca holocarpa (Hoffm.) A.E.Wade				+
152. Xanthoria candelaria (L.)Th.Fr.				+
153. Xanthoria parietina (L.) Th.Fr.	+			+
154. Xanthoria polycarpa (Hoffm.)Th.Fr. ex Rieber	+			
155. Dermatocarpon luridum (With.) J.R.Laundon	+		+	
156. Phlyctis argena (Spreng.) Flot.	+		+	+
Total	118	53	81	84

Fig. 2-43. Distribution of rare and remarkable vascular plants, hepatics and lichens in northern Karelia.

● *New records* ○ *Previous records*

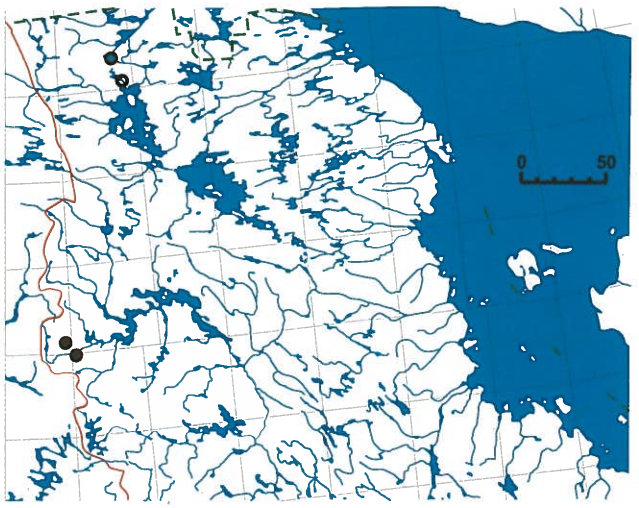

Fig. 2. Agrostis clavata Trin.

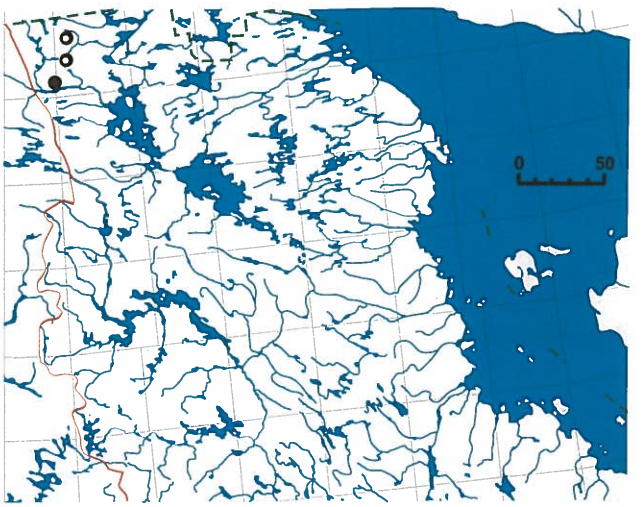

Fig. 3. Arabis alpina L.

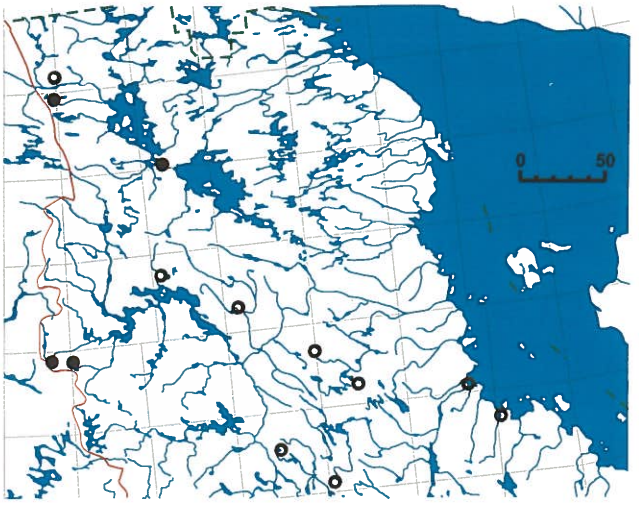

Fig. 4. Botrychium lanceolatum (S. G. Gmel.) Angstr.

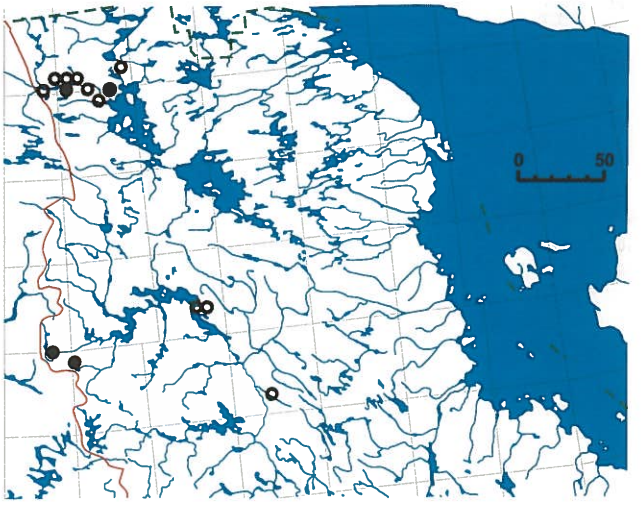

Fig 5. Diplazium sibiricum (Turch.) Jermi

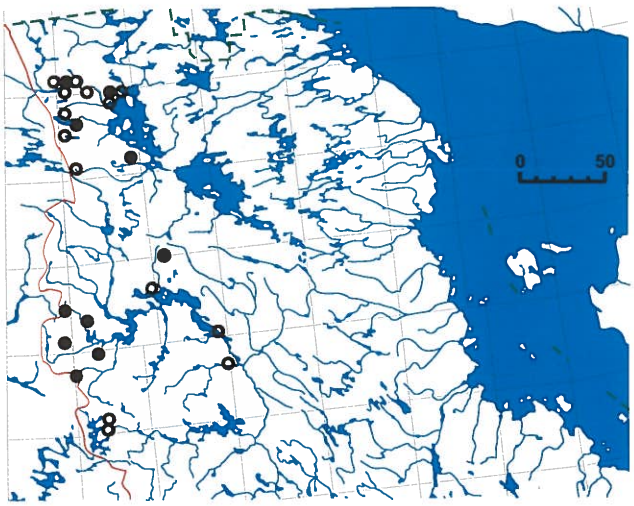

Fig. 6. Epilobium hornemannii Reichenb.

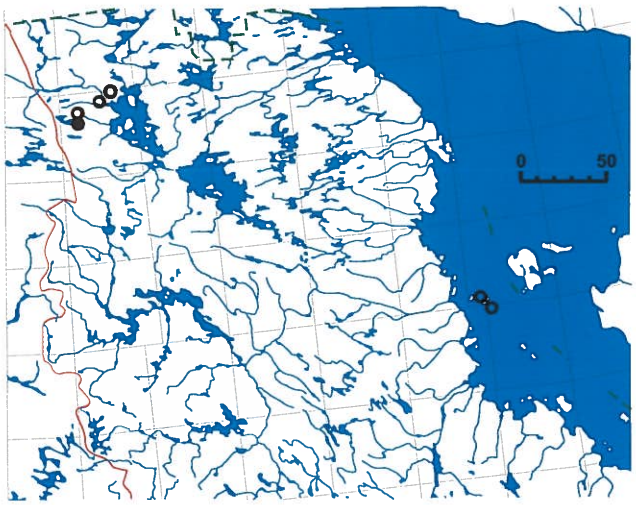

Fig. 7. Loiseleuria procumbens (L.) Desv.

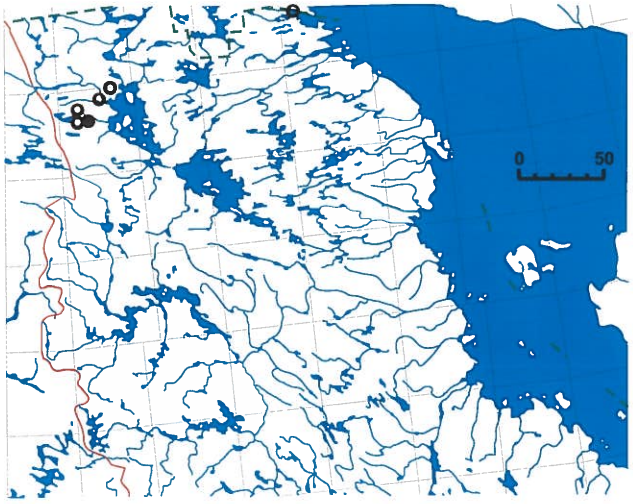

Fig. 8. Phyllodoce caerulea (L.) Bab.

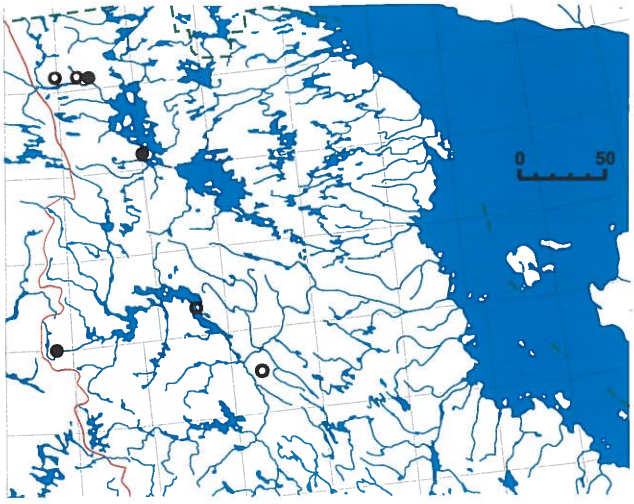

Fig. 9. Pteridium aquilinum (L.) Kuhn.

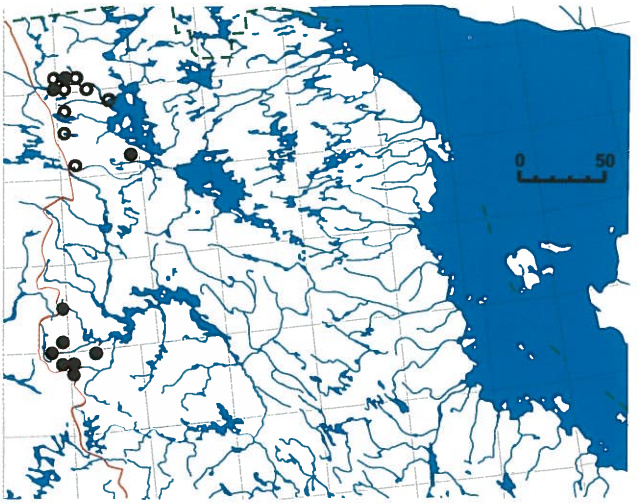

Fig 10. Stellaria calycantha (Ledeb.) Bong.

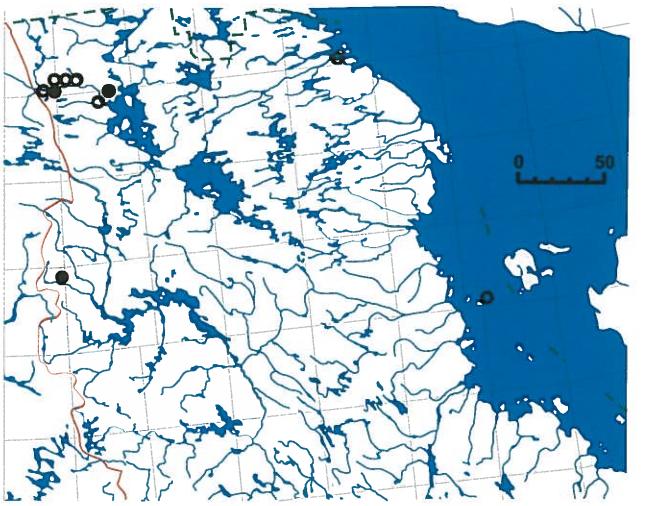

Fig. 11. Thymus subarcticus Klock. & Schost.

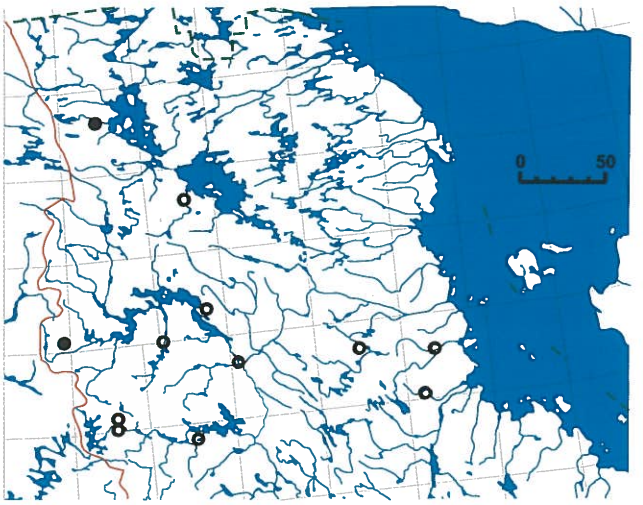

Fig. 12. Viburnum opulus L.

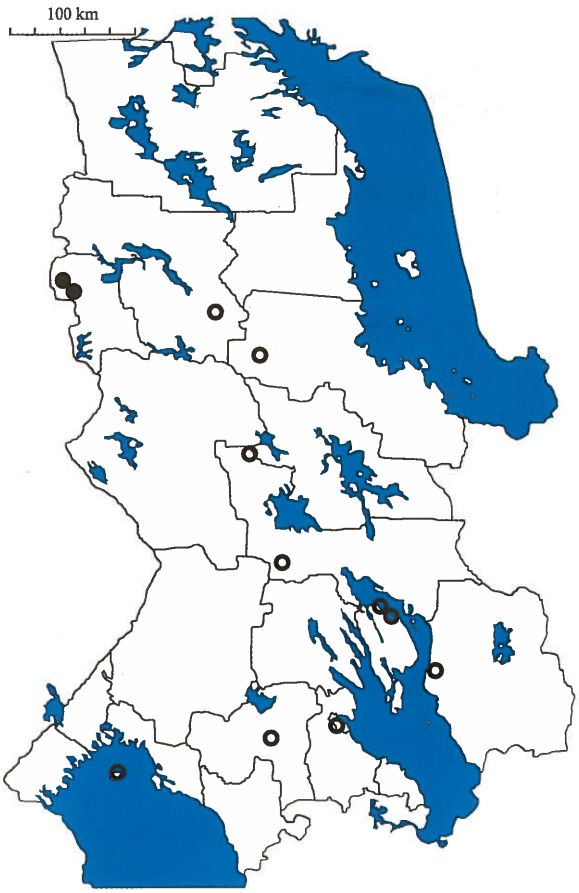

Fig. 13. Dactylorhiza cruenta (O. F. Muel.) Soo

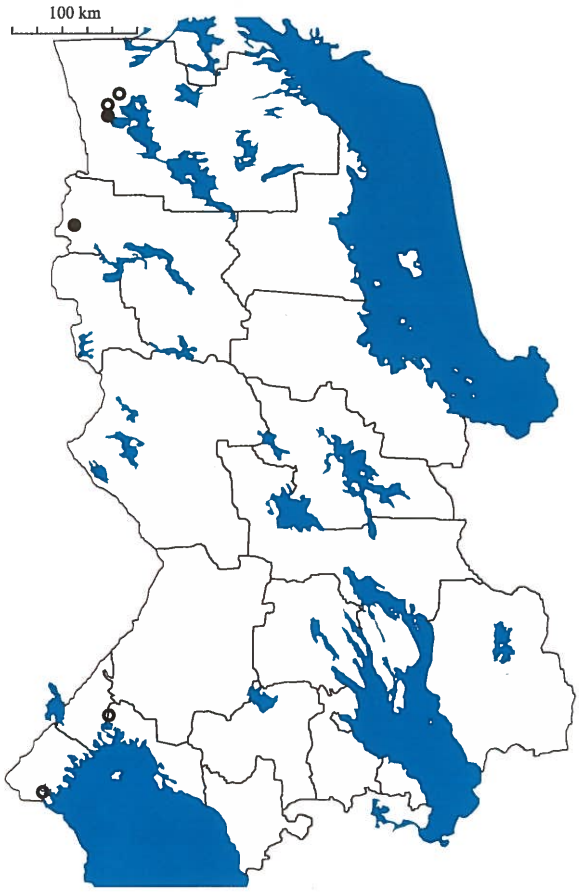

Fig. 14. Helictotrichon pubescens (Huds.) Pilger

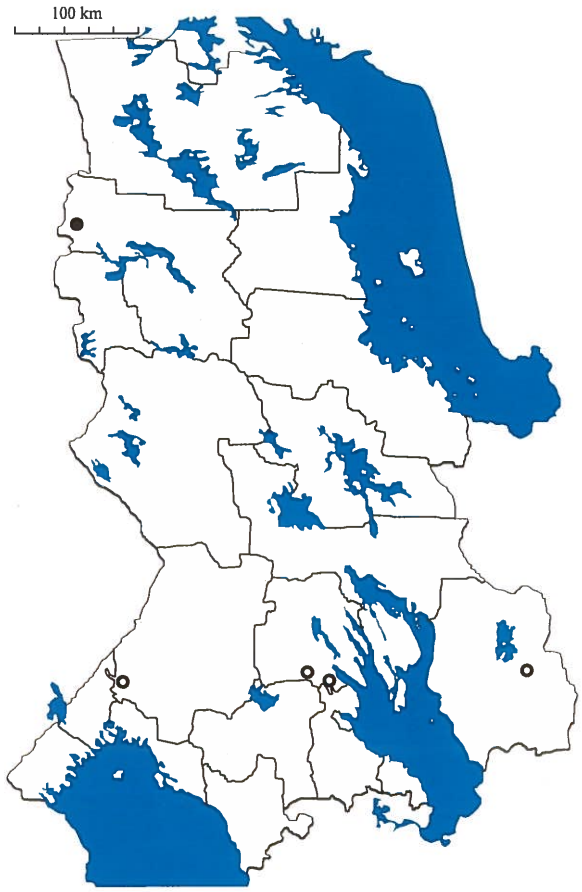

Fig. 15. Impatiens noli-tangere L.

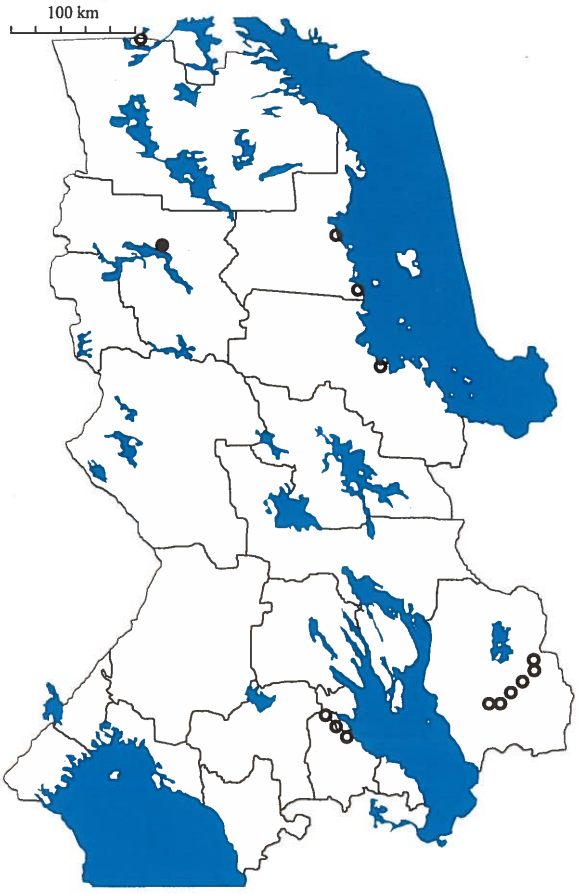

Fig. 16. Moehringia lateriflora (L.) Fenzl

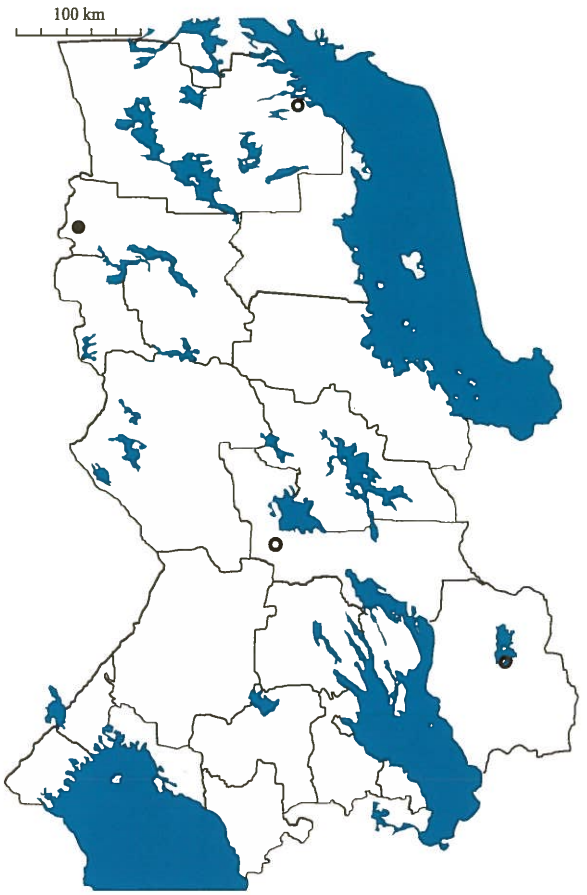

Fig. 17. Moehringia trinervia (L.) Clairv.

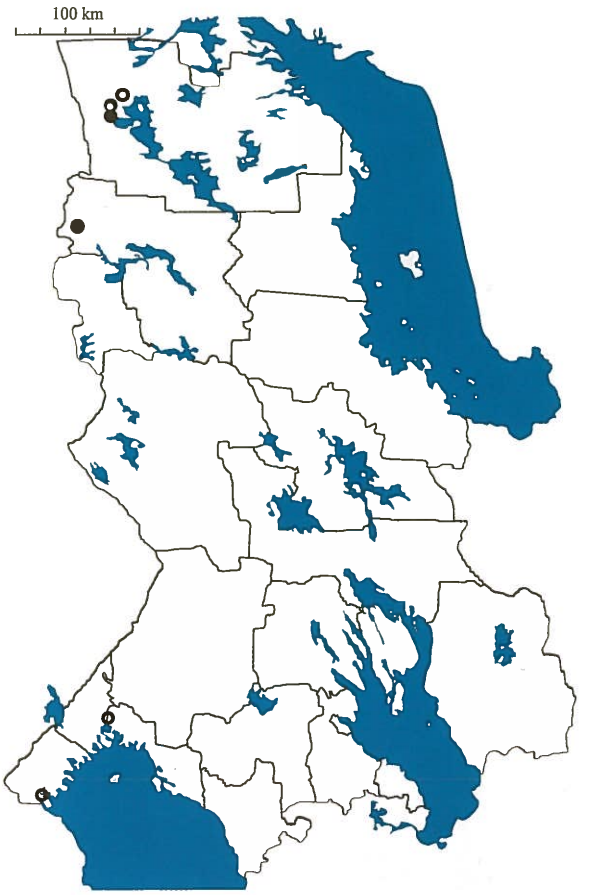

Fig. 18. Potentilla crantzii (Crants) G. Beck ex Fritsch.

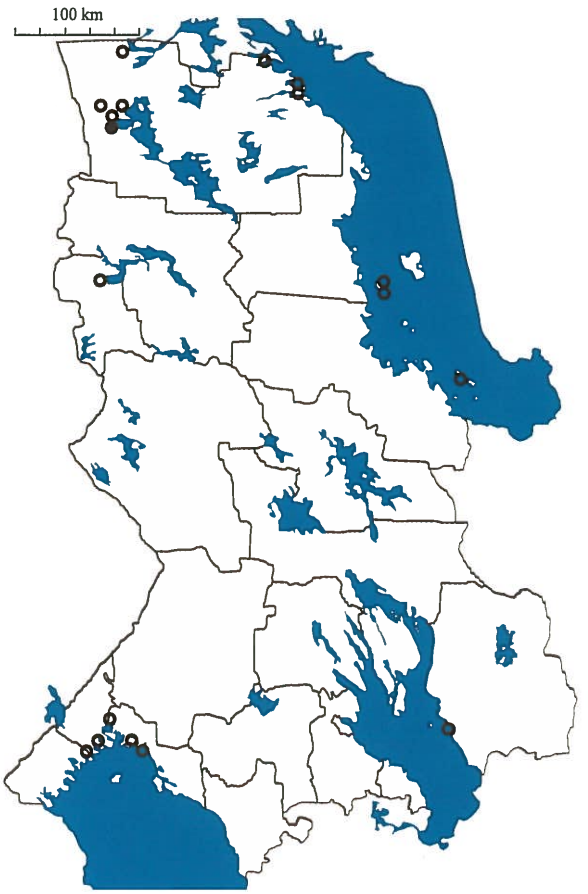

Fig. 19. Steris alpina

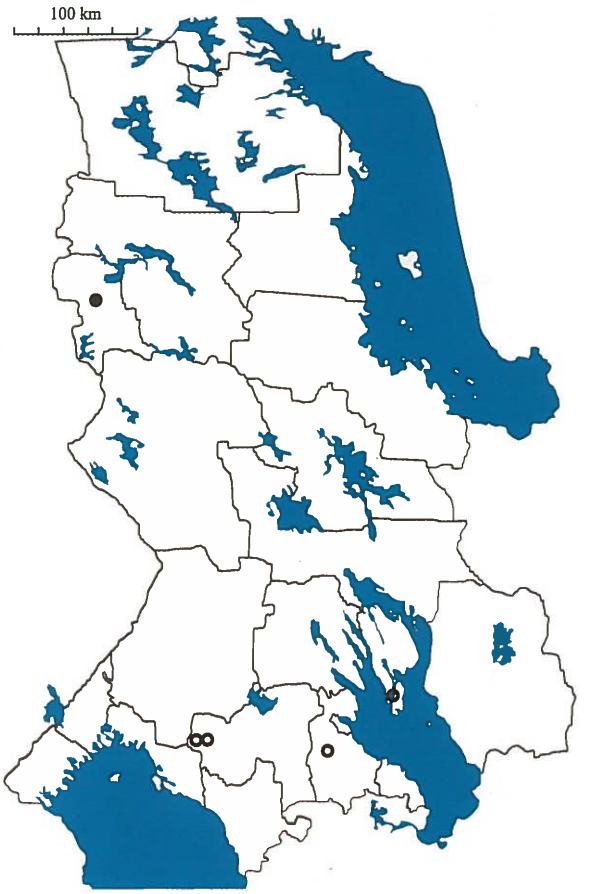

Fig. 20. Thlaspi caernlescens G. & C. Presl.

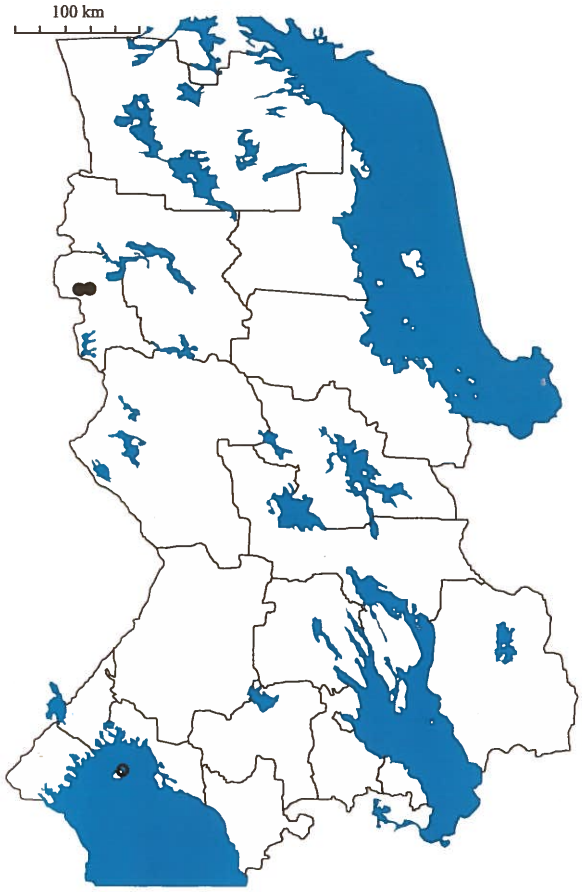

Fig. 21. Valeriana sambucifolia (L.) Fenzl

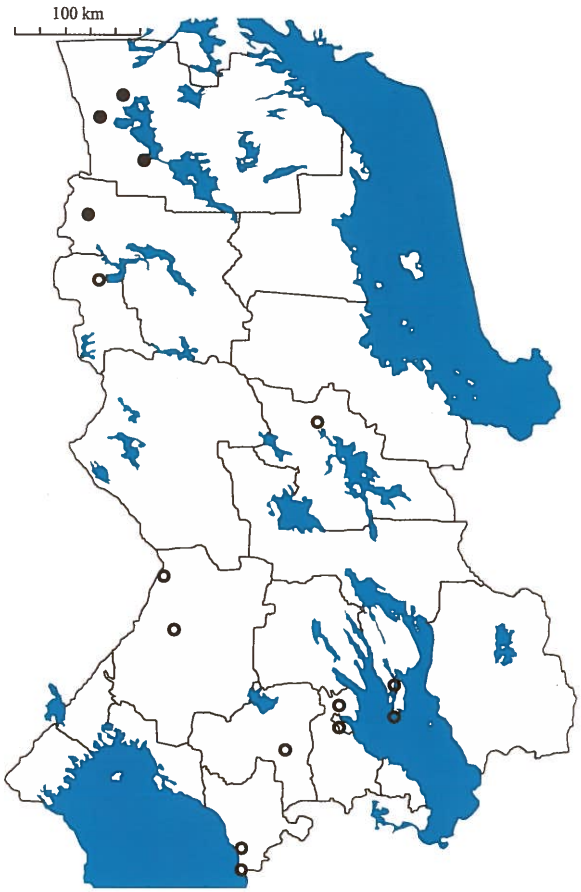

Fig. 22. Calypogeia muelleriana (Schiffn.) K. Muell.

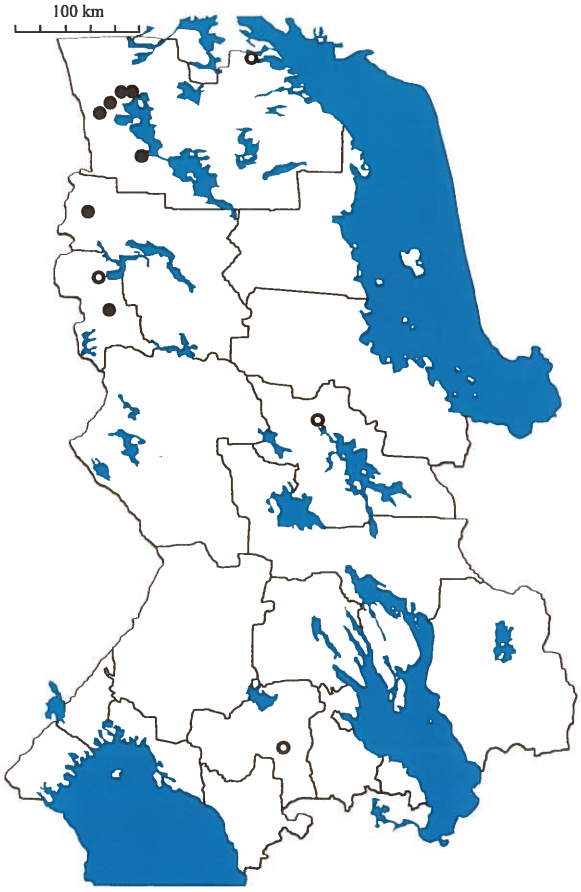

Fig. 23. Calypogeia sphagnicola (H. Arn. & J. Perss.) Warnst. & Loeske

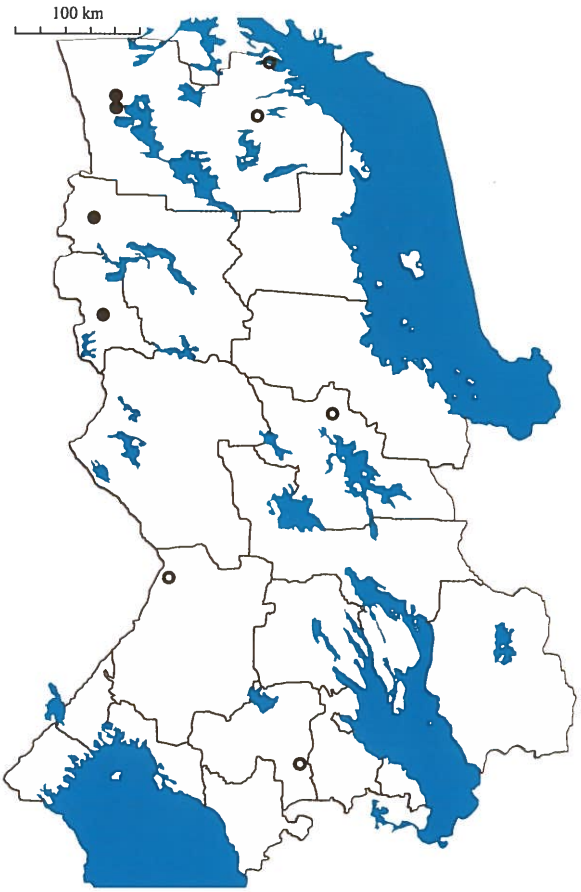

Fig. 24. Cephalozia leucantha Spruce

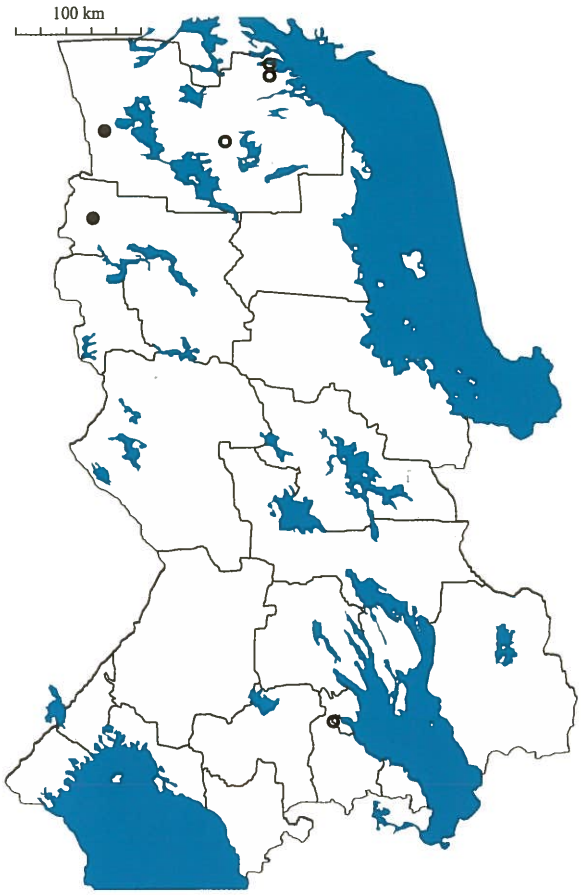

Fig. 25. Cephalozia loitlesbergeri Schiffn.

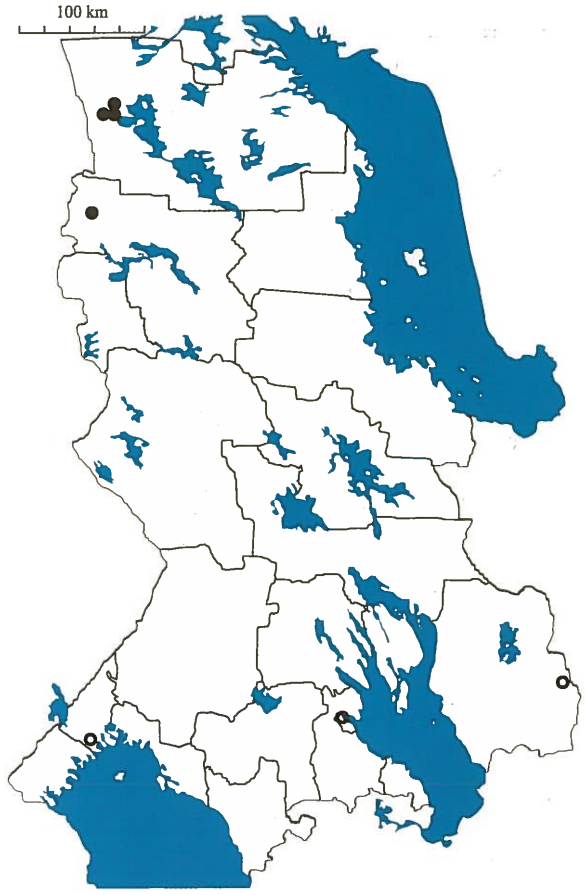

Fig. 26. Conocephalum conicum (L.) Und

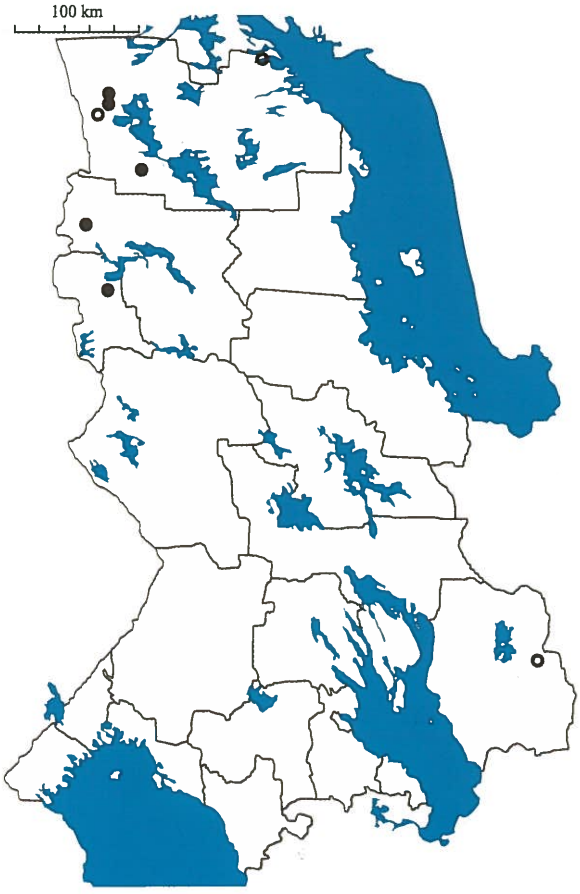

Fig. 27. Crossocalyx hellerianus (Nees ex Lindenb.) Meyl

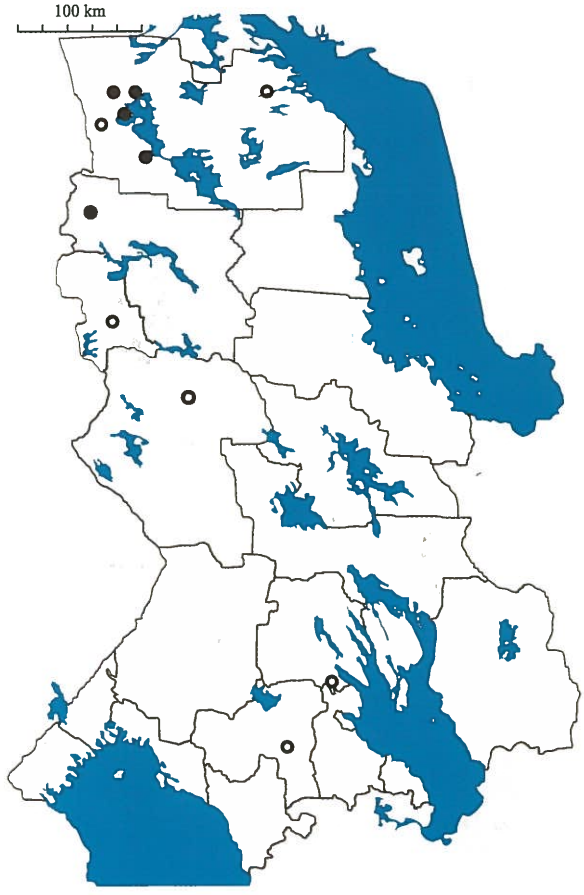

Fig. 28. Harpanthus flotovianus (Nees) Nees

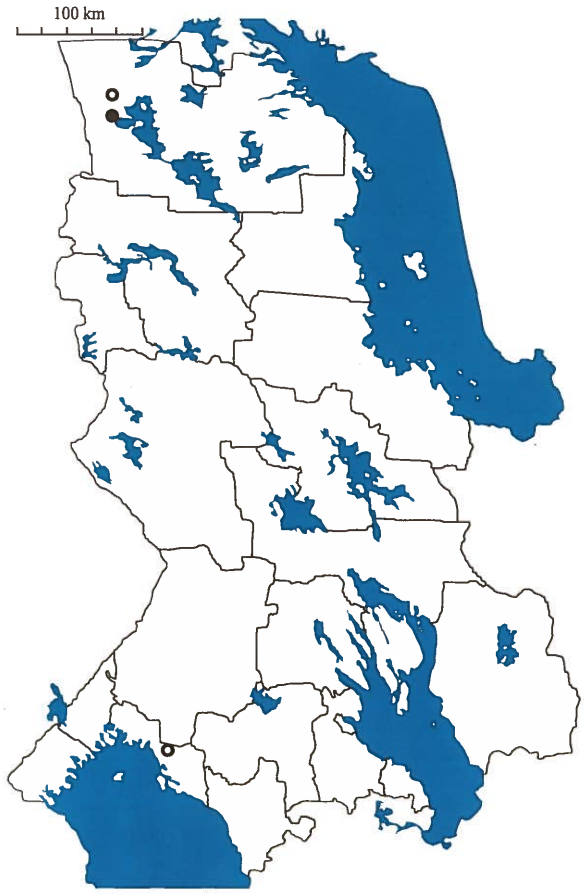

Fig. 29. Lophozia ascendens (Warnst.) Achust.

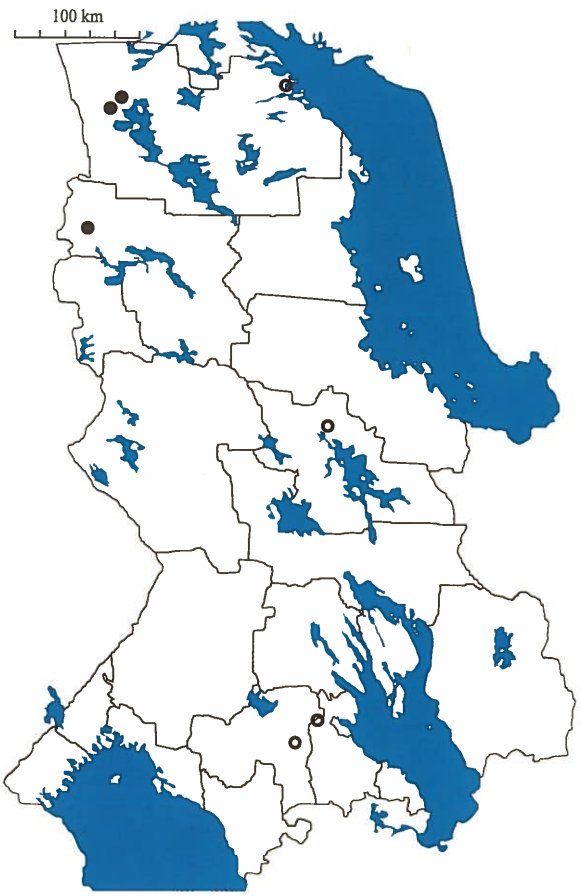

Fig. 30. Lophozia confertifolia Schiffn.

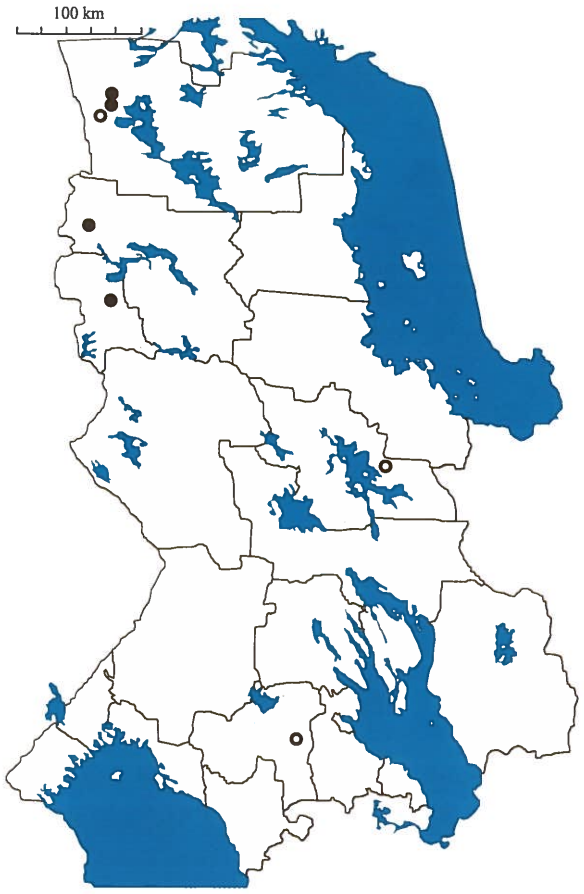

Fig. 31. Odontoschisma elongatum (Lindb.) Evans

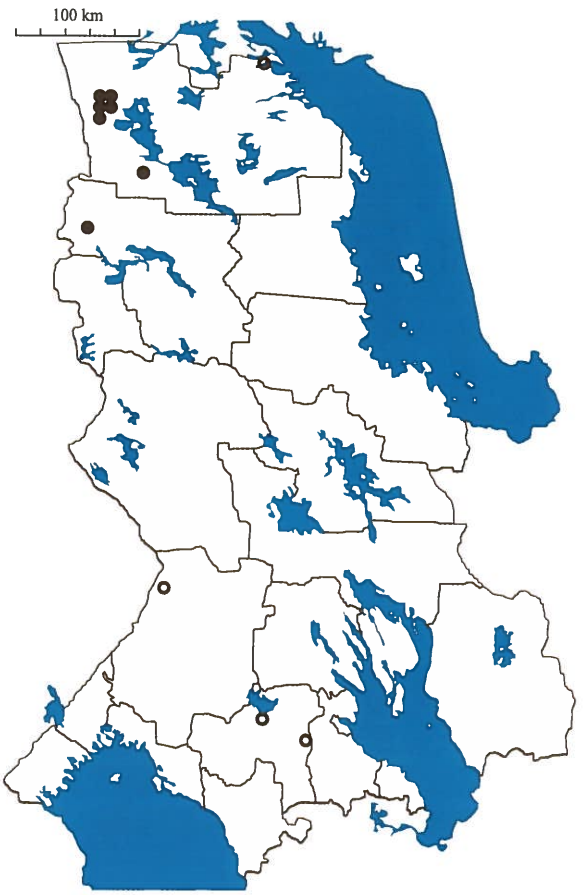

Fig. 32. Orthocaulis attenuatus (Mart.) Evans.

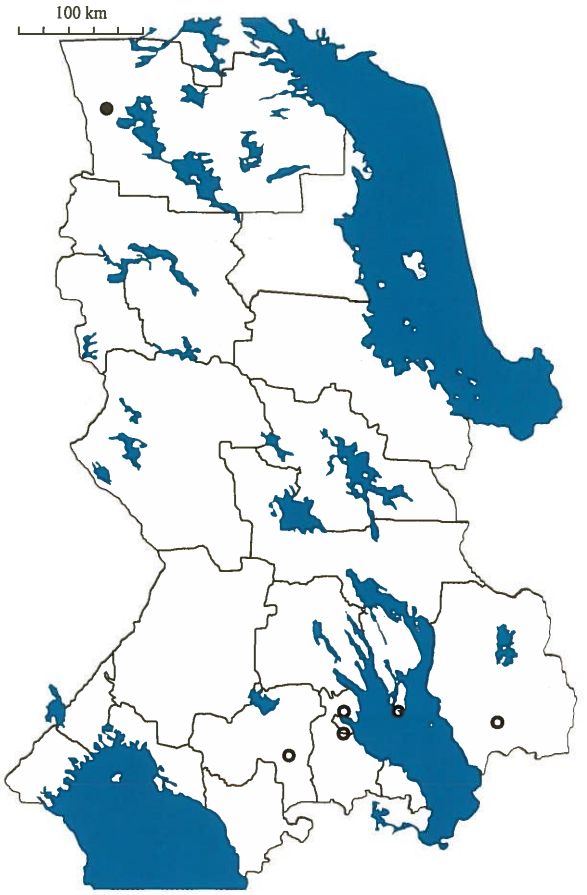

Fig. 33. Plagiochila major (Nees) S. Arnell.

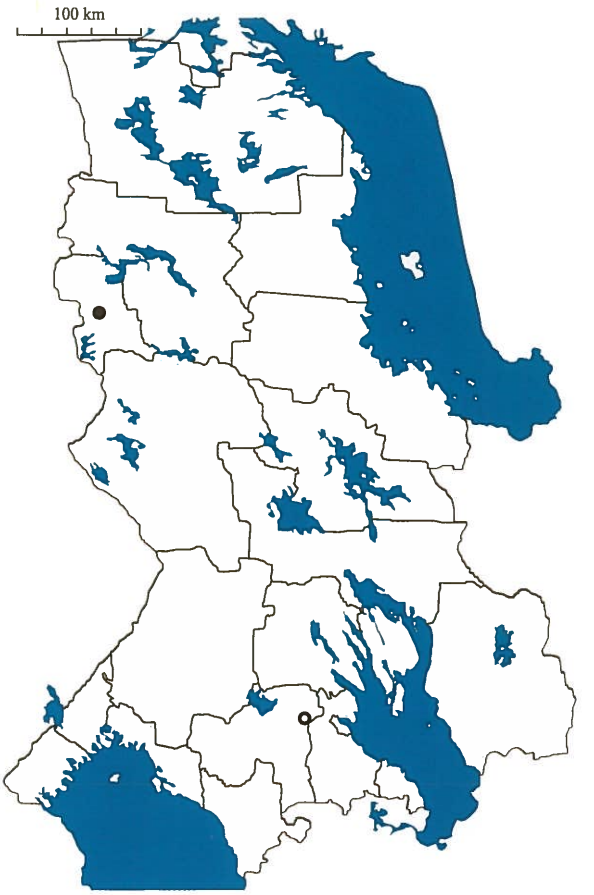

Fig. 34. Riccardia multifida (L.) S. Gray

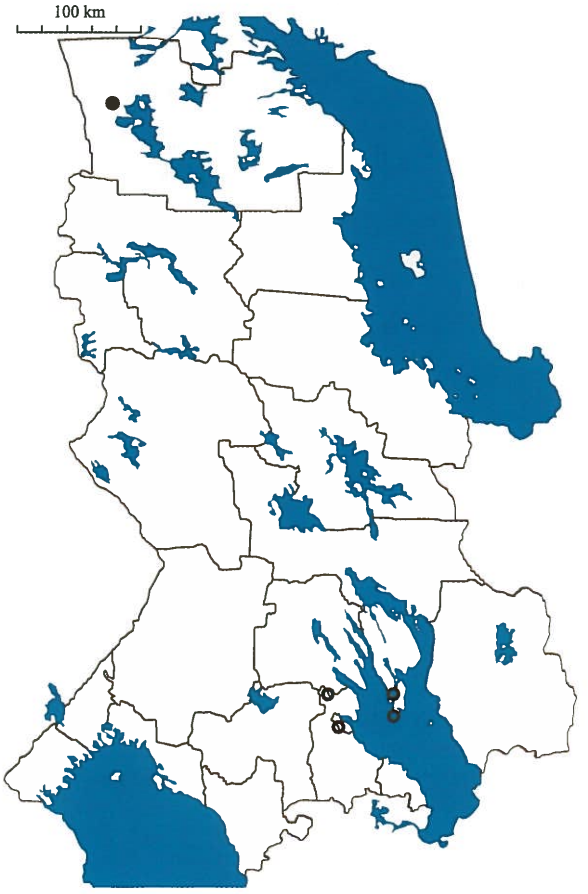

Fig. 35. Riccardia palmata (Hedw.) Carruth.

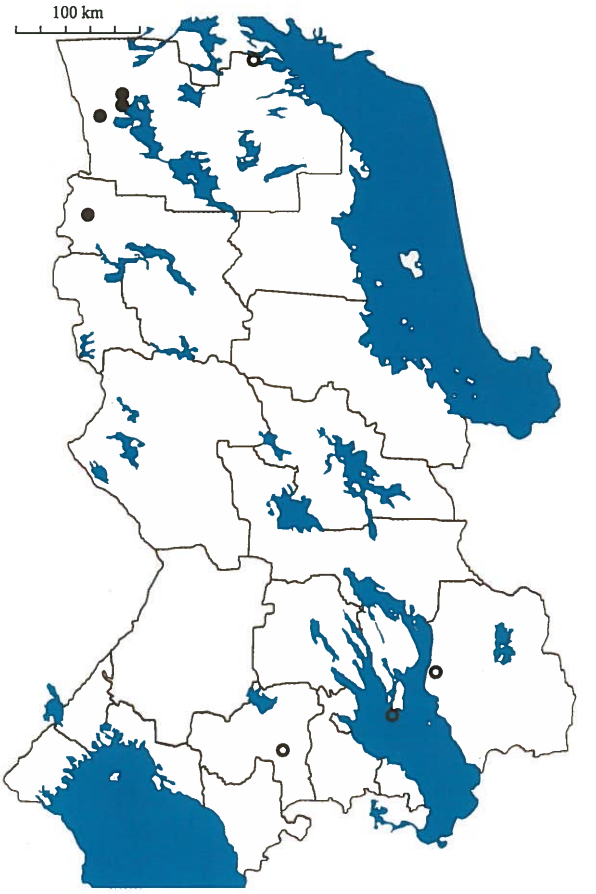

Fig. 36. Schistochilopsis incisa (Schrad.) Konst.

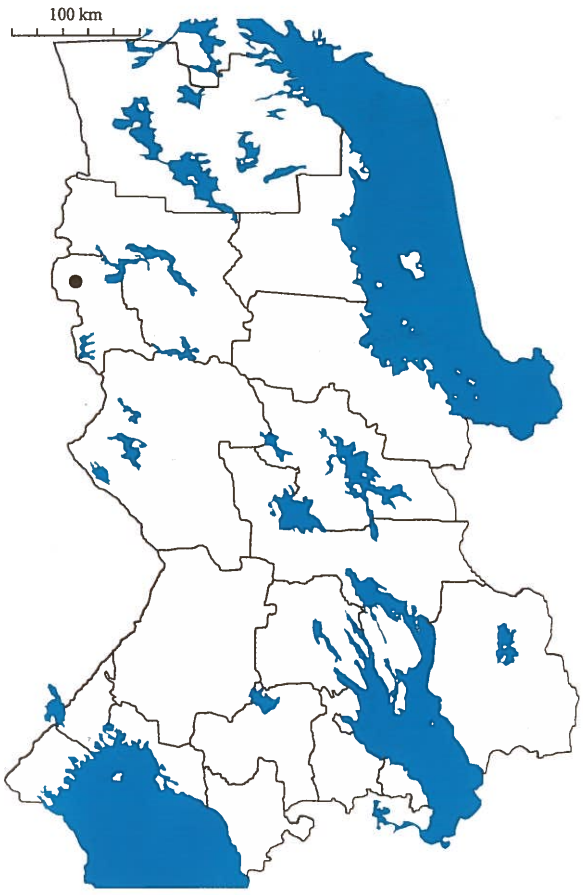

Fig. 37. Artonia incarnata Th. Fr. ex Almq.

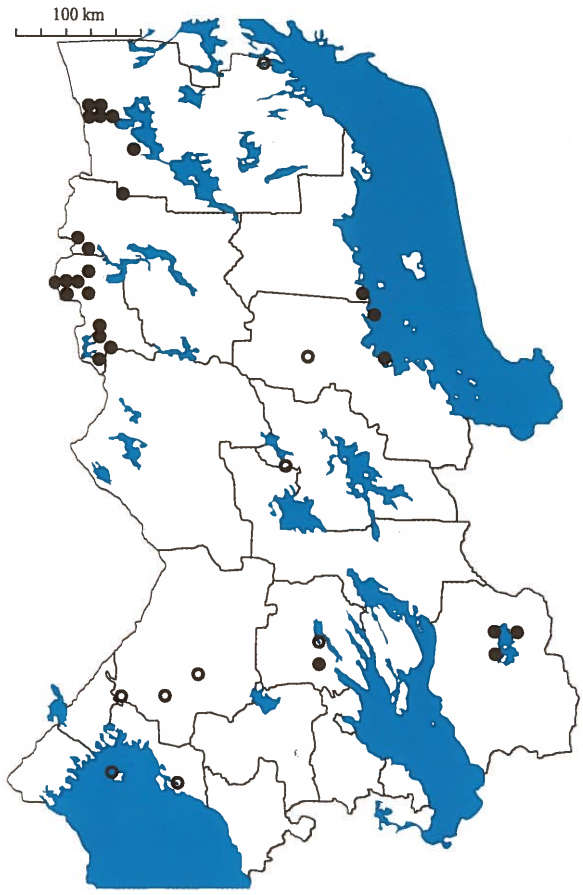

Fig. 38. Bryoria fremontii

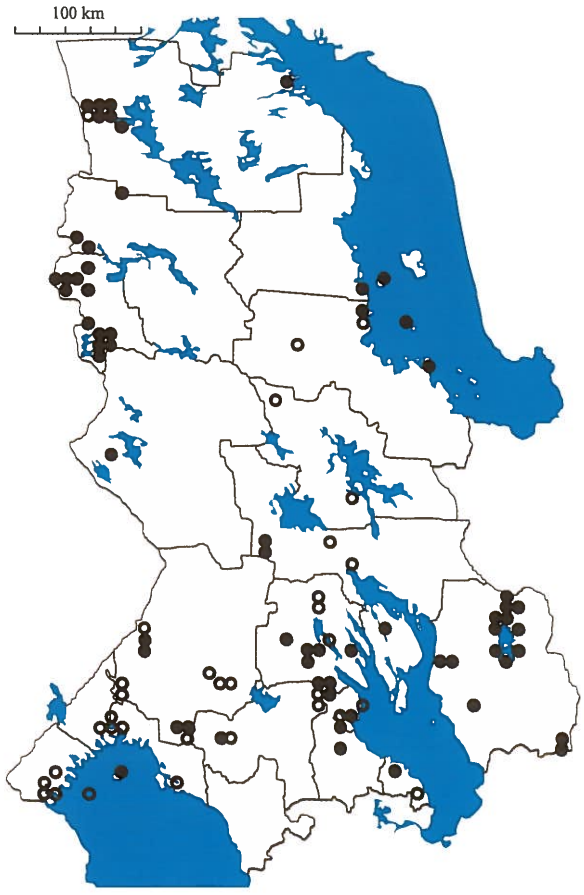

Fig. 39. Lobaria pulmonaria (L.) Hoffm.

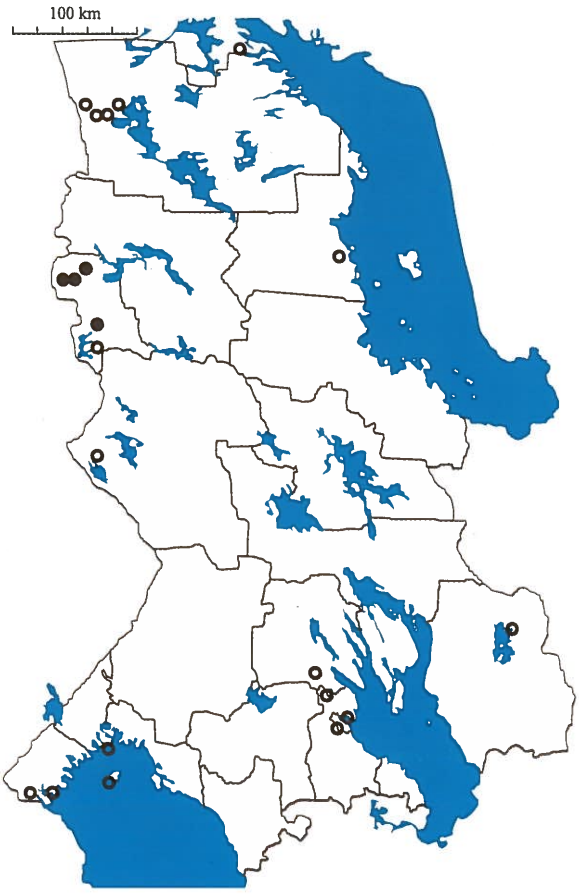

Fig. 40. Nephroma bellum (Spreng.) Tuck.

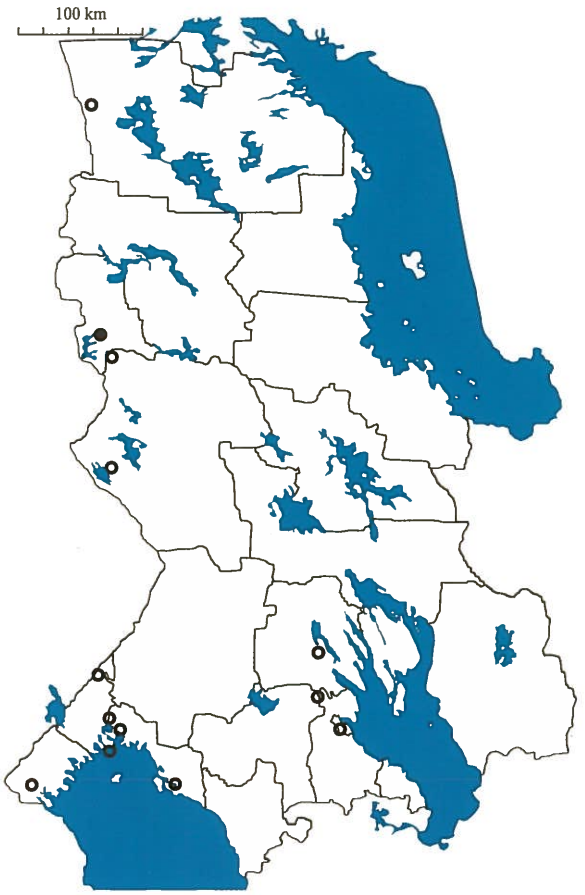

Fig. 41. Dermatocarpon luridum (With.) J.R. Laundon

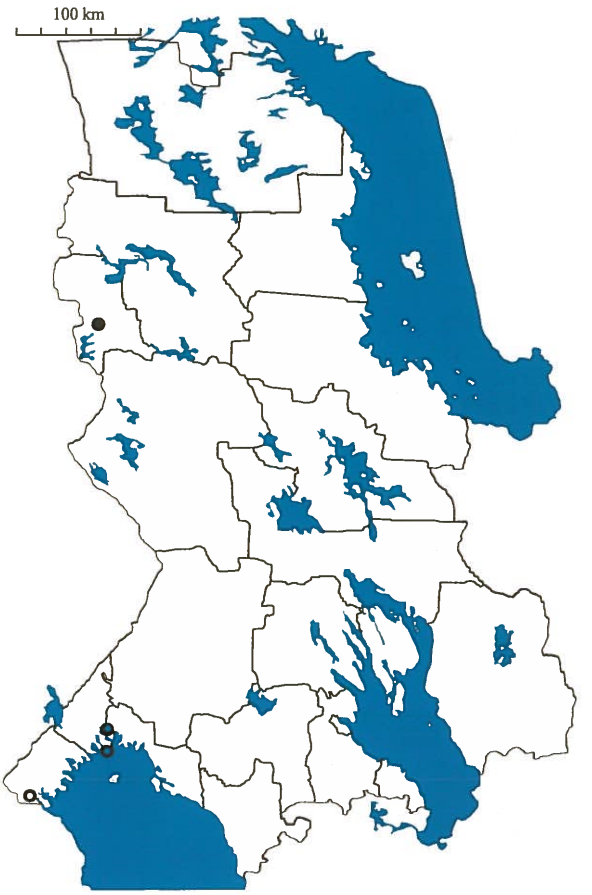

Fig. 42. Stereocaulon dactylophyllum Florke

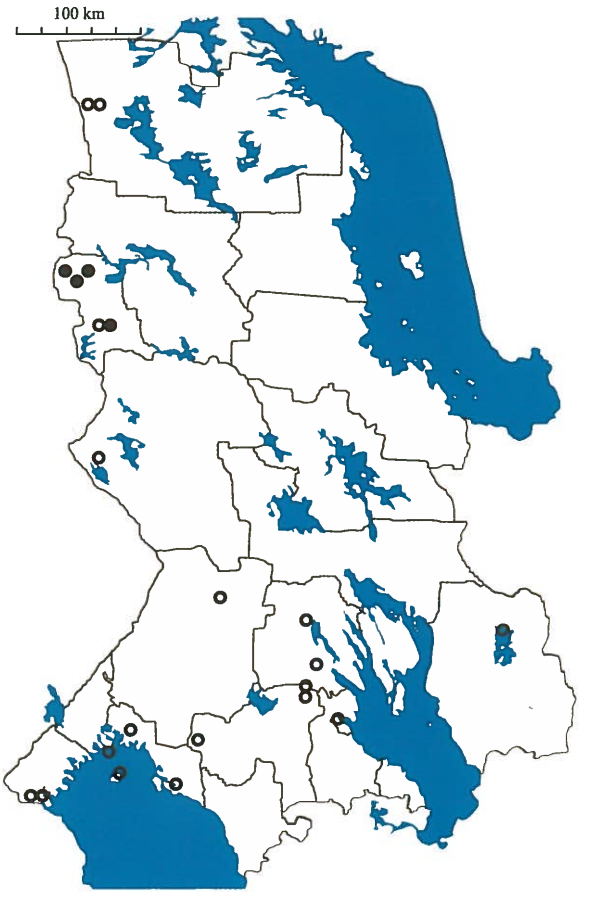

Fig. 43. Ramalina dilacerata (Hoffm.) Hoffm.

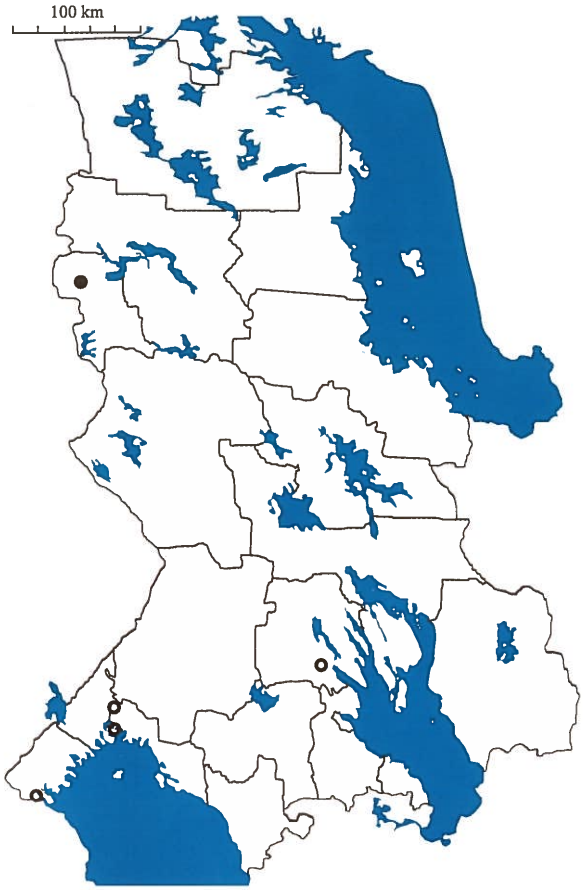

Fig. 44. Usnea barbata (L.) F.H. Wigg.

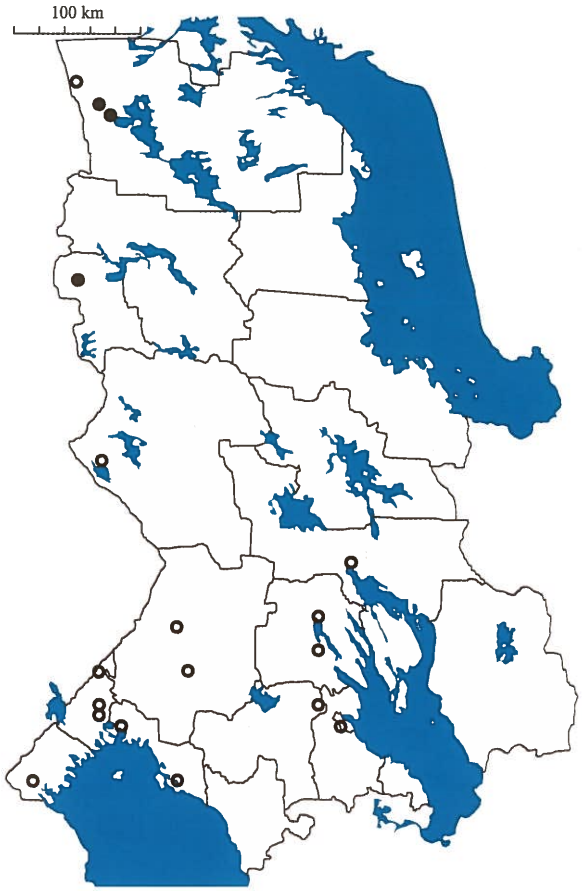

Fig. 45. Evernia divaricata

Mire ecosystems and bryoflora of the proposed Kalevala National Park

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Karelian Research Centre,
Institute of Biology, Laboratory of Mire Ecosystems

Abstract

A study has been made of the vegetation, structure, stratigraphy and dynamics of mire ecosystems in the territory of the proposed Kalevala National Park. Some 100 000 hectares in area, the proposed park is located within the Karelia pomorica occidentalis (KPOC) biogeographical province. The study investigated the bryoflora of all types of ecosystems occurring within the territory. The moss flora of the proposed park contains 152 species of bryophytes belonging to 67 genera and 25 families. Five of these species are included in the Red Data Book of Karelia (1995) and the Kotiranta et. al. (1998). In all, bryological investigations in the proposed Kalevala National Park and the Kostamus State Nature Reserve have revealed 40 moss species new to the KPOC province. This brings the total number of moss species within the province to 236. Five species (*Oligotrichum hercynicum, Dicranella rufescens, D. palustris, Ulota crispa* and *Hydrohypnum smithii*) were recorded for the first time in Karelia.

Mires occupy between 20 % and 60 % of the total area of the Park. They usually form complex mire systems dominated by sedge – *Sphagnum* and pine – dwarf shrub – *Sphagnum* massifs. Aapa mires are much less frequent. Peat deposits are up to five or six metres thick. Most mires are underlain by a layer of sapropel (gyttja), indicating their lacustrine genesis.

An ecological–floristic classification of the mire vegetation of Karelia has recently been composed (Kuznetsov 1993, 1998). It includes 36 associations, some of which comprise a number of sub–associations and faciations. The survey at Kalevala National Park investigated plant associations with a broad spectrum of sub–associations and faciations. Additionally, a comparative analysis has been made of the biodiversity of mire plant communities found within both existing and proposed nature reserves located along the Finnish–Russian border.

Key words: national park, mire ecosystems, vegetation, stratigraphy, dynamics, bryoflora

Introduction

The idea of establishing the Kalevala National Park, incorporating significant areas of old virgin forests located in the territory adjacent to the Finnish–Russian border, was put forward in the late 1980s by the Laboratory of Nature Protection, Forest Research Institute of the Karelian Research Centre, Russian Academy of Sciences. In 1997, studies of the nature of the proposed territory were initiated by various field researchers (including biologists, geologists, hydrologists, historians and ethnographers. The aim was to draw up comprehensive scientific grounds for the urgent establishment of a nature reserve and the definition of its physical boundaries. As a result of these investigations a great volume of data on the flora, fauna, hydrography, geology and history of the area has been collected and the scientific arguments explaining the necessity of setting up a Kalevala National Park in this territory have been presented. Several options concerning the park's boundaries (enclosing areas of between 90 and 115 thousand hectares) have been proposed (Gromtsev 1998). The territory of the planned park is highly paludified. All the mires are in their virgin state and are quite diverse in terms of plant species composition, plant cover and peat deposit structure.

General characteristics of the territory of the proposed Kalevala National Park

The proposed Kalevala National Park is situated in the district of Kostamus (Fig. 1). It is located on the watershed of the Baltic and White Seas and the major part of its water runoff is carried by the River Venehjoki into Lake Ylä-Kuittijärvi and then further on into the White Sea. Within the proposed park area there are a total of 250 small rivers and streams, and 1 380 lakes, together covering some 145 km^2.

The territory is generally composed of poor acid Lower Archean gneisses and granites some 3,15 x 10^9 years in age. Bedrocks are covered by quaternary glacial, glaciofluvial and limnoglacial deposits. The territory is characterised by hilly–ridge relief. Outcrops of bedrock are more frequent in the eastern part of the Park (Gromtsev, 1998).

According to accepted geobotanical classification the park territory is located within the north taiga subzone and in the West Karelian region of the Kola–Karelian sub–province within the North European taiga province (Yurkovskaya 1993). The adjacent territory of Finland belongs to the northern boreal zone, North Ostrobothnia region (Atlas of Finland 1988). Forests occupy about 70 % of the total area of the park. Pine stands of various types are predominant, comprising 85 % of the total forested area. Spruce accounts for 10 %. Small areas of birch and aspen occur at sites of forest fires and of former hay meadows. The average age of the forest within the park is 120–160 years although individual pines up to 450 years in age have been found. Natural forest fires have had a great influence on the dynamics of the forest ecosystems of the area. In drier parts of the territory they occur on average about once every hundred years. A significant degree of selective felling has been carried out. The proposed park is situated within the north–western part of the Kem floristic region (Ramenskaya 1983) or, according to the Scandinavian biogeographical classification, in the Karelia pomorica occidentalis province (Mela & Cajander 1906) (Fig.1). In accordance with ATLAS Florae Europaeae (Jalas & Suominen 1972) the territory of the park lies within compartments PN–2, UT–2, PM–1 and US–1.

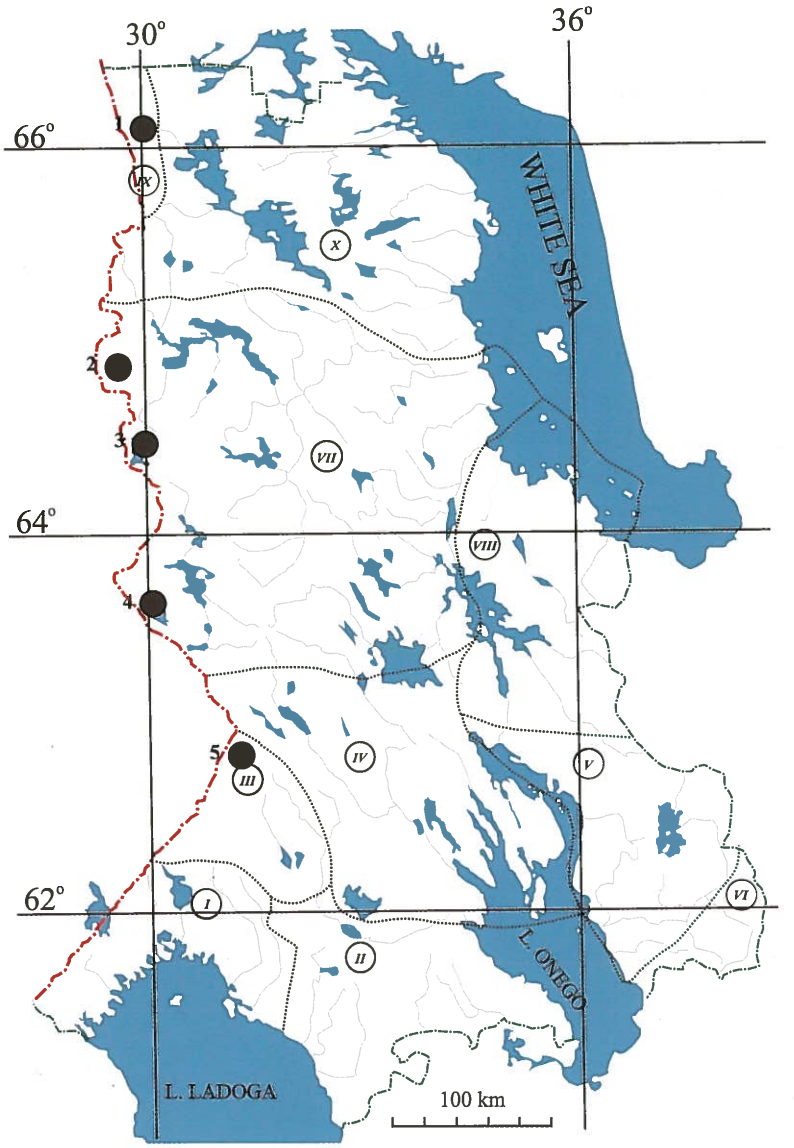

Fig. 1. Location of nature protected territories in west Karelia. 1 - Paanajärvi National Park (NP), 2 - Kalevala NP (proposed), 3 - Kostamus Nature Reserve, 4 - Tuulos NP (proposed), 5 - Koitajoki NP (proposed). Floristical regions of Karelia (from: Ramenskaya 1983 and biogeographical provinces from Mela & Cajander 1906). I - Priladozhskyi (Kl-Karelia ladogenesis), II - Olonetskyi (Kol-Karelia olonetsensis), III - Suojarvskyi (Kb-Karelia borealis), IV - Zaonezhskyi (Kon-Karelia onegensis), V - Vodlozerskyi (Kton-Karelia transonegensis), VI - Pudozhskyi (Kp-Karelia pudogensis), VII - Kemskyi (Kpoc-Karelia pomorica occidentalis), VIII - Vygozerskyi (Kpor-Karelia pomorica orientalis), IX - Severo-sapadnyi gornyi (Ks-Kuusamo), X - Topozerskyi (Kk-Karelia keretina).

The flora of vascular plants occurring in the proposed park is rather poor owing to the northern location of the territory, its short geological age and the paucity of the bedrock and soils present. There are 403 species of vascular plants, 333 indigenous and 70 adventitious plants, including several rare and protected species (Kravchenko et al. 1998). There is almost no existing data on the bryoflora of the region.

Quite a high degree of biodiversity of bryoflora has been recorded in the area under study. The 152 species of true mosses found make up 64 % of the Kem floristic region bryoflora and 35 % of the total Karelian moss flora (Boychuk 1999).

According to the regional subdivision of mires in Karelia this territory belongs to the region of aapa and mesotrophic grass–*Sphagnum* mires of the West Karelian Uplands (Elina et al. 1984) (Fig. 2). No field studies had been conducted in the area prior to 1997. The adjacent territory of Finland is classified as belonging to the region of southern aapa mires in the sub–region of Kainuu (Ruuhijärvi 1988).

In addition to the proposed Kalevala National Park there is a number of planned nature protection territories (NPT) and established parks situated along the Finnish–Russian border (Fig. 1, 2). The biodiversity of the proposed park's mire ecosystems have been analysed in comparison with the mires of these strictly protected nature territories and, especially, with those of the Kostamus State Nature Reserve, which is closest to Kalevala in terms of natural characteristics. Several publications describing the mires of the Kostamus reserve and the Friendship Park are available (Elina & Kuznetsov 1977, Kuznetsov et al. 1996, Kolomytsev & Kuznetsov 1997, Heikkilä et al. 1997).

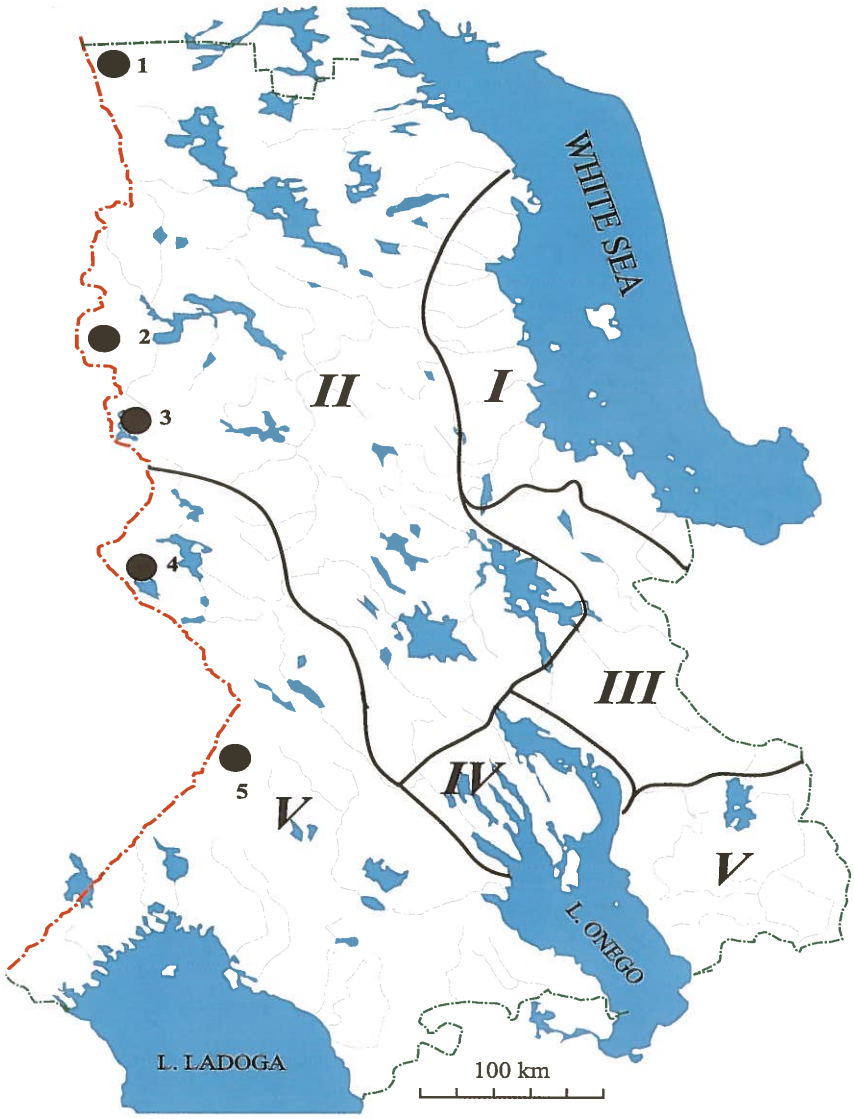

Fig. 2. The regional division of mire complexes in Karelia. Regions: I - dystrophic and ombrotrophic (O) ridge-hollow bogs, II - aapa fens, III - O ridge-hollow bogs, IV - eutrophic grass and grass-Bryales fens, V - O ridge-hollow bogs and mesotrophic grass-Sphagnum fens. Nature Protected Territories: 1 - Paanajärvi NP, 2 - Kalevala NP, 3 - Kostamus NR, 4 - Tuulos NP, 5 - Koitajoki NP.

Methods

A general picture of the degree of paludification of the Kalevala park territory, as well as of the size, shape and patterns of its mire ecosystems, was gained using topographical maps (1:100 000 and 1:50 000) in conjunction with colour satellite images (1:100 000). The lack of modern air photographic surveys has complicated the mapping of mire types according to the principles of Russian mire typology (Kats 1971, Yurkovskaya 1980).

Applying the Russian school of thought to the present study of the structure and diversity of mire ecosystems, the following levels of hierarchical structure are taken into account: plant communities (associations), mire sites (facies), mire massifs (mire site complexes) and mire systems (Galkina 1959, Masing 1984). The mire systems typical of the park were identified and further field investigations carried out. Field work included the taking of stratigraphic profiles across the central parts of mires. Mire sites lying along these profiles were classified and described in geobotanical terms. Peat samples were taken from the deepest parts of mire as well as at major mire sites and margins lying along the profiles. Macrofossil analysis and an examination of the degree of decomposition were conducted on the samples. The samples of peat were taken in layers of 20–25 cm. Thin layers differing visually in structure and humification were sampled separately.

Peat samples (each weighing approximately 100 grams) were first packed. The degree of peat decomposition was determined at the laboratory using a microscopic method (Minkina & Varlygin 1939) to a degree of accuracy of +/-5 %. After panning each sample under tap water using an 0,25 mm sieve the peat macrofossil content was analysed under the microscope (Korotkina 1939). The proportion of macrofossils of some peat levels was determined to the nearest 5 % with the help of atlases of plant macrofossils (Dombrovskaya et al. 1959, Kats et al. 1977). Peat types were determined on the basis of the ratio of macrofossils present according to the system of peat classification established by Russian mire researchers (Classification... 1951, Elina et al. 1984). Palaeocommunities were identified and their trophic status determined according to the occurrence of predominant plant remains in the various peat layers.

Mire sites are distinguished according to the composition and structure of their plant cover. According to the Russian approach to mire science, mire sites are often called 'facies' (Lopatin 1954). Facies are categorised into simple structured facies and patterned (complex) ones. Simple structured facies have no microrelief and are usually occupied by a single plant community (association). Patterned facies are characterised by a well developed microtopography (ridge–hollow, string–flark, hummock–plain etc.) and their plant cover is made up of several communities, each confined to particular elements of the microrelief. In the case of the present study geobotanical descriptions were made using specially designed forms. Examinations were made of the structure of mire sites, their microrelief patterns (forms), sizes and proportions. Descriptions of the floristic composition of plant communities within each mire site were made at the centre of each respective site. The abundance of each plant species according to the Braun–Blanquet scale (Braun–Blanquet 1964) was determined and their coverage recorded to the nearest 5 %. In order to ensure the thoroughness of the study, geobotanical releves of mire vegetation were performed both along the profiles and in other parts of mires.

A classification of mire communities was composed according to the ecological–floristic method (Braun–Blanquet 1964) commonly used in Europe (Nordhagen 1943, Dierssen 1982, Rybnicek et al. 1984, Moen 1990). In addition, a number of plant associations were analysed and several new ones identified (Kuznetsov 1998).

An investigation was carried out into the vascular plant flora of mires along stratigraphic profiles and along field routes within the area of the proposed park. Samples of plant species collected are kept in the Herbarium at the Institute of Biology, Karelian Research Centre, Russian Academy of Sciences. The naming of plants accords with the system of nomenclature established by Cherepanov (1995).

The bryophyte flora of the biotopes of the park were studied as the area had not previously been visited by bryologists. Investigations were carried out along routes from which moss samples from various virgin and anthropogenic habitats were taken. More than 500 moss samples were collected and identified with the help of a number of handbooks (Abramova et. al. 1961, Savitch–Lubitskaya & Smirnova 1968, Nyholm 1954–1969, Hedenäs 1993) as well as by comparison with standard moss samples kept at the Laboratory of Mire Ecosystems. The samples are now housed in the Herbarium at the Institute of Biology, Karelian Research Centre, Russian Academy of Sciences. The nomenclature of mosses follows Ignatov & Afonina (1992).

Results of the study

Vascular plant flora of mires.

A floristic study of 403 species of vascular plants was conducted and the results published (Kravchenko et al. 1998). The flora of the proposed park is rather poor owing to its northern geographic situation and the impoverished character of it bedrock and soils. 115 species of vascular plants were recorded in mires and paludified forests. This represents 29 % of the entire flora of the park and 40 % of all the plant species growing on the mires of Karelia (Kuznetsov 1995a). The most common families of mire flora occurring in the park are Cyperaceae (32 species) and Poaceae (10 species). There are no eutrophic mires in the area and therefore most calciphilous and eutrophic plants are absent. Some northern species rare to Karelia are found here at the southern extreme of their distribution. These include *Epilobium hornemannii* Reichenb., *Stellaria calycantha* (Ledeb.) Bong., *S.calycantha x longifolia* Willd. and *Poa alpigena* (Blytt) Lindm.
Carex diandra Schrank, *C.rhynchophysa* C. A.Mey, *Dactylorhiza traunsteineri* (Saut.) Soo s.l. and *D.cruenta* (O. F. Mül.). *Soo* were found in small springs and along brooks. These are all southern species which do not grow further north in Karelia. Certain mire plant species are included in the Red Data Book of Russia (1988) (*Carex livida* (Wahlenb.) Willd., *Dactylorhiza traunsteineri*) and in the Red Data Book of Karelia (1995) (*Carex livida, Dactylorhiza traunsteineri, Carex tenuiflora* Wahlenb., *Dactylorhiza cruenta, Epilobium hornemannii, Stellaria calycantha*) (Fig. 3). Some eutrophic mire species generally common throughout Karelia are in the area under study of relatively fragmentary and sparse occurrence (*Carex flava, C. buxbaumii, Frangula alnus, Alnus kolaënsis, Salix cinerea, S. pentandra*).

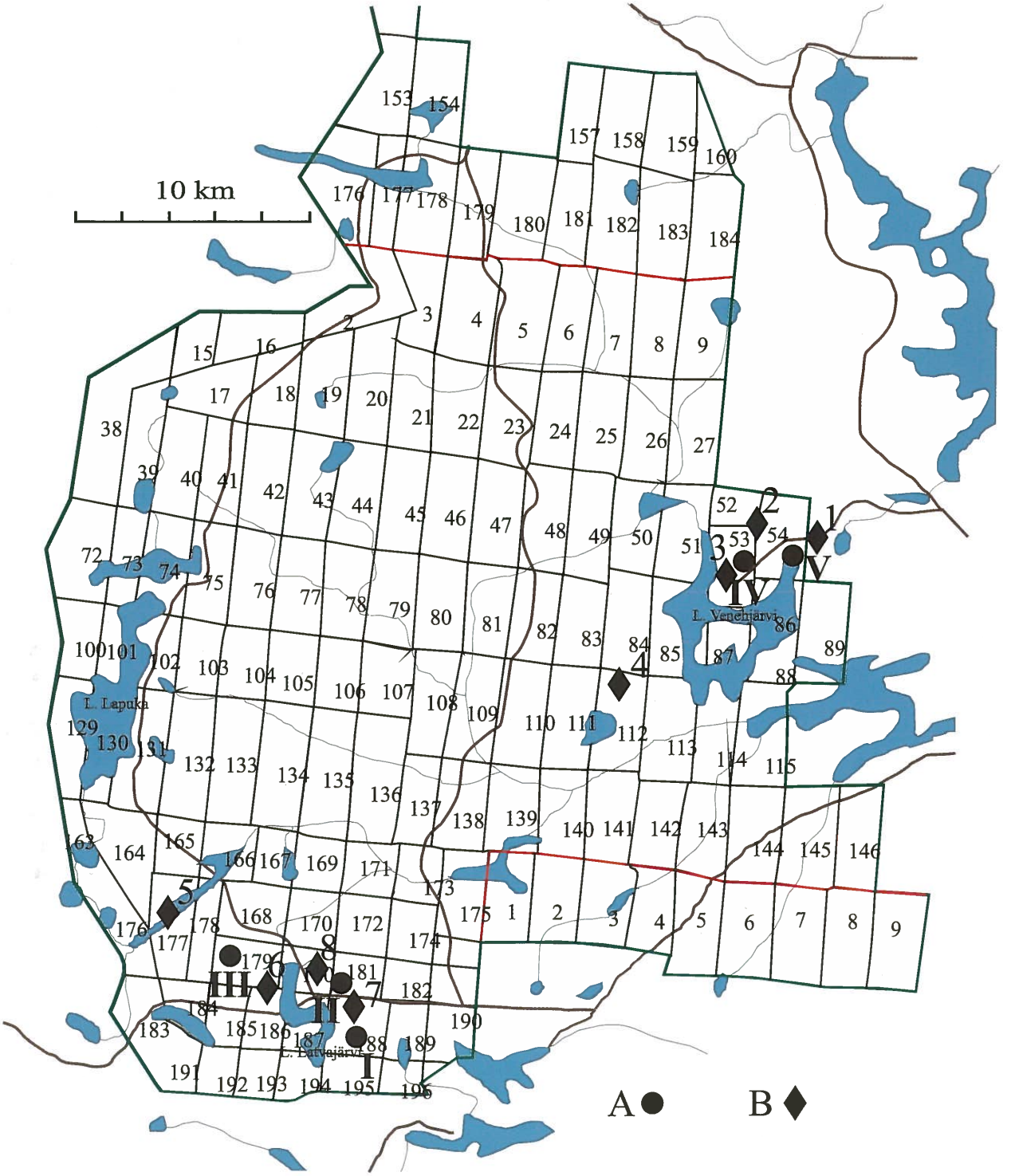

Fig. 3. Mires, investigated stratigraphically in Kalevala national park A: I- Latvasuo, II - Stansuo, III - Vasensuo, IV - Virsusuo, V - Pridorozhnoe. Rare vascular plants recorded in mires (B): 1,2 - Frangula alnus; 3 - Carex rhynchophysa, C. livida; 4 - Carex diandra, 5 - C. buxbaumii, C. flava, Frangula alnus, Juncus bulbosus; 6 - Alnus kolaënsis; 7 - Carex livida, C. diandra, Dactylorhiza cruenta, Stellaria calycantha; 8 - Epilobium hornemannii.

Flora of Bryophytes

The bryoflora of the proposed Kalevala National Park has not been previously studied. 152 moss species belonging to 67 genera and 25 families (Table 1) were identified during the course of the study. These account for 64 % of the bryoflora of the Kem floristic region (236 moss species) and 35 % of all Karelian moss flora (437 species). According to the published moss list of Karelia (Volkova & Maksimov 1993) only 196 moss species had been previously identified in the Kem floristic region.

15 species (*Sphagnum flexuosum, Oligotrichum hercynicum, Discelium nudum, Dicranella rufescens, Plagiomnium elatum, Calliergon megalophyllum, Hamatocaulis vernicosus, Hygroamblystegium fluviatile, Hygrohypnum alpestre, Warnstorfia pseudostraminea, Brachythecium campeste, B. rutabulum, B. starkei, Pseudotaxiphyllum elegans, Hylocomiastrum umbratum*) were reported for the first time for the Kem floristic region. *Oligotrichum hercynicum* and *Dicranella rufescens* were found for the first time in Karelia (Boychuk, 1998).

The most widely represented families were *Sphagnaceae* (31 species), *Dicranaceae* (21) and *Amblystegiaceae* (21) (Table 1). Bryophytes displaying a northern distribution pattern dominate the bryoflora, making up 61 % of all species. Some 90 % of the bryophyte species are of circumpolar distribution.

77 different moss species were found in forests, 72 in mires, 25 in meadows, 48 on exposed rocks, 90 in water bodies and shore habitats, and 26 in disturbed habitats.

Most species are of widespread occurrence within the area. Other species, such as *Sphagnum contortum, S. wulfianum, Atrichum undulatum, Tetraplodon angustatus, Dicranum elongatum, D. fragilifolium, D. spurium, Rhodobryum roseum, Calliergon giganteum, C. megalophyllum, Rhodobryum roseum, Hygroamblystegium fluviatile, Hamatocaulis vernicosus, Hypnum pallescens* etc. occur sporadically within the park (i.e. in one or two places only). *Fontinalis squamosa, Discelium nudum, Dicranella rufescens, Warnstorfia pseudostraminea* and *Pseudotaxiphyllum elegans* are listed in the Red Data Book of Karelia (1995) and of East Fennoscandia (1998).

In recent years a detailed study has been made of the bryoflora of the Kostamus Nature Reserve which lies 50 km to the south of the Kalevala National Park. The Kostamus reserve is also situated in the Kem floristic region and the Karelia pomorica occidentalis province (Boychuk 1999). Its moss flora is consists of 175 species of true mosses belonging to 73 genera and 28 families (Table. 1). 22 moss species (*Sphagnum denticulatum, S.quinquefarium, S.subnitens, Racomitrium affine, Orthotrichum speciosum, Ulota crispa, Cnestrum schistii, Dicranella palustris, Schistostega pennata, Bryum argenteum, B.crebberimum, B.imbricatum, Pohlia andalusica, Plagiomnium medium, Pseudoleskea radicosa, Calliergonella cuspidata, Drepanocladus aduncus, Hydrohypnum smithii, Limprichtia cossonii, Eurynchium striatulum, Plagiothecium nemorale, Hylocomiastrum pyrenaicum)* were reported for the first time for the Kem floristic region (Boychuk 1999). Of these, three mosses (*Ulota crispa, Dicranella palustris* and *Hydrohypnum smithii*) were identified for the first time anywhere in Karelia.

Taking the studies of the Kostamus reserve and proposed Kalevala park together, a total of 193 moss species were identified. This represents 82 % of the entire Kem floristic region bryoflora (236 species). Taken together, the two territories contain eight moss species listed in the Red Data Book of Karelia (1995) and the Kotiranta et. al. (1998). These are *Sphagnum denticulatum* (Kostamus), *S.subnitens* (Kostamus), *Eurynchium striatulum* (Kostamus), *Fontinalis squammisa* (Kostamus, Kalevala), *Discelium nudum* (Kalevala), *Dicranella rufescens* (Kalevala), *Warnstorfia pseudostraminea* (Kostamus, Kalevala) and *Pseudotaxiphyllum elegans* (Kalevala).

The bryoflora of the Kalevala park and Kostamuksha reserve are rather similar to one another (Table. 1). Thus, a similarity index of 69 % (134 species common to both territories) has been be calculated.

Table 1. List of mosses of Kem floristic region

1 - Brotherus, 1923; 2 - Volkova, Maksimov, 1993; 3 - PNP "Kalevala"; 4 - Kostamus Nature Reserve

Families and species	1	2	3	4
Sphagnaceae				
Sphagnum angustifolium (Russ.) C. Jens		+	+	+
S. aongstroemii C. Hartm.		+	+	+
S. balticum (Russ.) Russ. ex C. Jens.		+	+	+
S. capillifolium (Ehrh.) Hedw.		+	+	+
S. centrale C.Jens. ex H.Arnell et C.Jens.		+	+	+
S. compactum DC.		+	+	+
S. contortum Schultz		+	+	+
S. cuspidatum Ehrh. ex Hoffm.		+		+
S. denticulatum Brid.				+
S. fallax (Klinggr.) Klinggr.		+	+	+
S. fimbriatum Wils.		+	+	+
S. flexuosum Dozy et Molk.			+	+
S. fuscum (Schimp.) Klinggr.		+	+	+
S. girgensohnii Russ.		+	+	+
S. inundatum Russ.		+	+	+
S. jensenii H.Lindb.		+	+	+
S. lindbergii Schimp. ex Lindb.		+	+	+
S. magellanicum Brid.		+	+	+
S. majus (Russ.) C.Jens.		+	+	+
S. obtusum Warnst.		+	+	+
S. papillosum Lindb.		+	+	+
S. platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.		+	+	+
S. pulchrum (Lindb. ex Braithw.) Warnst.		+	+	+
S. quinquefarium (Lindb. ex Braithw.) Warnst.				+
S. riparium Aongst.		+	+	+
S. rubellum Wils.		+	+	+
S. russowii Warnst.		+	+	+
S. squarrosum Crome		+	+	+
S. subfulvum Sjoers		+	+	+
S. subnitens Russ. et Warnst. ex Warnst.				+
S. subsecundum Nees ex Sturm		+	+	+
S. tenellum (Brid.) Perss. ex Brid.		+	+	+
S. teres (Schimp.) Aongstr. ex Hartm.		+	+	+
S. warnstorfii Russ.		+	+	+
S. wulfianum Girg.		+	+	+
Andreaeaceae				
Andreaea rupestris Hedw.	+	+	+	+

Families and species	1	2	3	4
Tetraphidaceae				
Tetraphis pellucida Hedw.	+	+	+	+
Polytrichaceae				
Atrichum tenellum (Rohl.) Bruch et Schimp. in B.S.G.		+	+	+
A. undulatum (Hedw.) P.Beauv.		+	+	
Oligotrichum hercynicum (Hedw.) DC. in Lam. et DC.			+	+
Pogonatum dentatum (Brid.) Brid.		+	+	+
P. urnigerum (Hedw.) P.Beauv.	+	+	+	+
Polytrichastrum alpinum (Hedw.) G.L.Sm.		+	+	+
Polytrichum commune Hedw.	+	+	+	+
P. pallidisetum Funck.		+		
P. jensenii Hag.		+		
P. juniperinum Hedw.	+	+	+	+
P. longisetum Sw. ex Brid.	+	+	+	+
P. piliferum Hedw.	+	+	+	+
P. strictum Brid.	+	+	+	+
P. swartzii Hartm.		+	+	+
Disceliaceae				
Discelium nudum (Dicks.) Brid.			+	
Funariaceae				
Funaria hygrometrica Hedw.	+	+		
Splachnaceae				
Splachnum ampullaceum Hedw.		+		+
S. luteum Hedw.	+	+	+	+
S. rubrum Hedw.		+	+	+
S. sphaericum Hedw.	+	+		
Tayloria tenuis (Dicks.) Schimp.	+	+		
Tetraplodon angustatus (Hedw.) Bruch et Schimp. in B.S.G.	+	+	+	+
T. mnioides (Hedw.) Bruch et Schimp. in B.S.G.		+		+
Buxbaumiaceae				
Buxbaumia aphylla Hedw.		+		
Pottiaceae				
Tortella fragilis (Hook. et Wils. in Drumm.) Limpr.		+		
Grimmiaceae				
Grimmia affinis Hoppe et Hornsch. ex Hornsch.		+		
G. muehlenbeckii Schimp.		+		
Racomitrium affine (Schleich. ex Web. et Mohr) Lindb.				+
R. canescens (Hedw.) Brid.		+	+	+
R. microcarpon (Hedw.) Brid.	+	+	+	+
Schistidium agassizii Sull. et Lesq. in Sull.		+	+	+
S. apocarpum (Hedw.) Bruch et Schimp. in B.S.G.	+	+	+	+
S. rivulare (Brid.) Podp.		+		+
S. strictum (Turn.) Mart.		+		
Seligeriaceae				
Blindia acuta (Hedw.) Bruch et Schimp. in B.S.G.		+		
Fissidentaceae				
Fissidens adianthoides Hedw.	+	+		+
F. osmundoides Hedw.		+	+	+
F. viridulus (Sw.) Wahlenb.	+	+		
Orthotrichaceae				
Amphidium lapponicum (Hedw.) Schimp.		+	+	+

Families and species	1	2	3	4
Orthotrichum rupestre Schleich. ex Schwaegr.	+	+		
O. obtusifolium Brid.	+	+	+	+
O. speciosum Nees in Sturm				+
Ulota crispa (Hedw.) Brid.				+
U. curvifolia (Wahlenb.) Lilj.	+	+	+	+
Ditrichaceae				
Ceratodon purpureus (Hedw.) Brid.	+	+	+	+
Distichium capillaceum (Hedw.) Bruch et Schimp. in B.S.G.	+	+		
Ditrichum heteromallum (Hedw.) Britt.		+	+	+
D. pusillum (Hedw.) Hampe		+		+
Dicranaceae				
Cnestrum alpestre (Wahlenb.) Nyh. ex Mogensen		+		
Cnestrum schistii (Web. et Mohr) Hag.				+
Cynodontium strumiferum (Hedw.) Lindb.		+	+	+
C. tenellum (Bruch et Schimp. in B.S.G.) Limpr.	+	+	+	
Dicranella cerviculata (Hedw.) Schimp.		+	+	+
D. crispa (Hedw.)	+	+	+	
D. palustris (Dicks.) Crundw. ex E. Warb.				+
D. rufescens (Dicks.) Schimp.			+	
D. subulata (Hedw.) Schimp.	+	+	+	+
Dicranoweisia crispula (Hedw.) Lindb.	+	+		+
Dicranum angustum Lindb.		+		+
D. bergeri Bland. in Starke	+	+	+	+
D. bonjeanii De Not.		+	+	+
D. brevifolium (Lindb.) Lindb.		+	+	
D. congestum Brid.	+	+	+	+
D. drummondii C.Muell.		+	+	+
D. elongatum Schleich. ex Schwaegr.	+	+	+	
D. fragilifolium Lindb.	+	+	+	+
D. fuscescens Turn.	+	+	+	+
D. majus Sm.	+	+	+	+
D. polysetum Sw.	+	+	+	+
D. scoparium Hedw.	+	+	+	+
D. spadiceum Zett.		+		+
D. spurium Hedw.	+	+	+	+
Kiaeria blyttii (Schimp.) Broth.	+	+		
Oncophorus compactus (Bruch et Schimp. in B.S.G.) Schljak.		+		
O. virens (Hedw.) Brid.	+	+		+
O. wahlenbergii Brid.	+	+	+	+
Orthodicranum flagellare (Hedw.) Loeske		+		
O. montanum (Hedw.) Loeske		+	+	+
Paraleucobryum longifolium (Hedw.) Loeske	+	+	+	+
Schistostegaceae				
Schistostega pennata Hedw.				+
Bryaceae				
Bryum argenteum Hedw.				+
B. caespiticium Hedw.	+	+	+	+
B. capillare Hedw.		+	+	
B. creberrimum Tayl.				+
B. cyclophyllum (Schwaegr.) Bruch et Schimp. in B.S.G.		+		

Families and species	1	2	3	4
B. elegans Nees ex Brid.		+		
B. imbricatum (Schwaegr.) Bruch et Schimp. in B.S.G.				+
B. pallens (Brid.) Sw. ex Roehl.	+	+	+	+
B. pseudotriquetrum (Hedw.) Gaertn. et al.	+	+	+	+
B. weigelii Spreng. in Biehler	+	+	+	+
Leptobryum pyriforme (Hedw.) Wils.		+	+	+
Pohlia andaluzica (Hoehnel)Broth.				+
P. bulbifera (Warnst.) Warnst.		+	+	+
P. cruda (Hedw.) Lindb.	+	+	+	+
P. nutans (Hedw.) Lindb.	+	+	+	+
P. proligera (Kindb. ex Breidl.) Lindb. ex H.Arnell		+		
Rhodobryum roseum (Hedw.) Limpr.	+	+	+	+
Mniaceae				
Cinclidium stygium Sw.	+	+	+	
Mnium hornum Hedw.		+		
M. ambiguum H.Muell.		+		
Plagiomnium cuspidatum (Hedw.) T.Kop.		+		+
P. elatum (B.S.G) T. Kop.			+	
P. ellipticum (Brid.) T.Kop.		+	+	+
P. medium (Bruch et Schimp. in B.S.G.) T.Kop.				+
Pseudobryum cinclidioides (Hueb.) T.Kop.	+	+	+	+
Rhizomnium magnifolium (Horik.)T.Kop.		+	+	+
R. pseudopunctatum (Bruch et Schimp.) T.Kop.		+	+	+
R. punctatum (Hedw.) T.Kop.	+	+	+	+
Aulacomniaceae				
Aulacomnium palustre (Hedw.) Schwaegr.	+	+	+	+
Meesiaceae				
Meesia longiseta Hedw.		+		
M. triquetra (Richter) Aongstr.	+	+	+	+
Paludella squarrosa (Hedw.) Brid.		+	+	+
Bartramiaceae				
Bartramia pomiformis Hedw.		+	+	+
B. ithyphylla Brid.		+		
Philonotis fontana (Hedw.) Brid.	+	+	+	+
Fontinaliaceae				
Dichelyma falcatum (Hedw.) Myr.	+	+	+	+
Fontinalis antipyretica Hedw.	+	+	+	+
F. dalecarlica Bruch et Schimp. in B.S.G.	+	+	+	+
F. squamosa Hedw.		+	+	+
Climaciaceae				
Climacium dendroides (Hedw.) Web. et Mohr.	+	+	+	+
Hedwigiaceae				
Hedwigia ciliata (Hedw.) Beauv.	+	+	+	+
Neckeraceae				
Neckera complanata (Hedw.) Hueb.	+	+		
N. pennata Hedw.		+		+
Pterigynandraceae				
Pterigynandrum filiforme Hedw.		+		+

Families and species	1	2	3	4
Leskeaceae				
Lescuraea saxicola (Schimp. in B.S.G.) Milde		+		
Leskea polycarpa Hedw.		+		
Leskeella nervosa (Brid.) Loeske		+		+
Pseudoleskea radicosa (Mitt.) Kindb. in Macoun				+
Pseudoleskeella tectorum (Funck ex Brid.) Kindb. in Broth.		+		
Thuidiaceae				
Abietinella abietina (Hedw.) Fleisch.		+		
Thuidium recognitum (Hedw.) Lindb.		+		
Helodiaceae				
Helodium blandowii (Web. et Mohr) Warnst.		+	+	+
Palustriella commutata (Hedw.) Ochyra		+		
Cratoneuraceae				
Cratoneuron filicinum (Hedw.) Spruce		+		
Amblystegiaceae				
Amblystegium serpens (Hedw.) Schimp. in. B.S.G.		+		+
Calliergon cordifolium (Hedw.) Kindb.	+	+	+	+
C. giganteum (Schimp.) Kindb.	+	+	+	+
C. megalophyllum Mikut.			+	
C. richardsonii (Mitt.) Kindb. in Warnst.		+		+
C. stramineum (Brid.) Kindb.	+	+	+	+
Calliergonella cuspidata (Hedw.) Loeske				+
Campylium chrysophyllum (Brid.)J.Lange		+		
C. polygamum (B.S.G.) C.Jens.	+	+	+	+
C. sommerfeltii (Myr.) J.Lange	+	+	+	+
C. stellatum (Hedw.) C.Jens.		+	+	+
Drepanocladus aduncus (Hedw.) Warnst.				+
Hamatocaulis vernicosus (Mitt.)Hedenaes			+	
Hygroamblystegium fluviatile (Hedw.) Loeske			+	
Hygrohypnum alpestre (Hedw.) Loeske			+	+
Hygrohypnum ochraceum (Turn.ex Wils.) Loeske	+	+		+
H. smithii (Sw. ex Lilj.) Broth.				+
Leptodictyum riparium (Hedw.) Warnst.			+	+
Limprichtia cossonii (Schimp.) Anderson et al.				+
L. revolvens (Sw.) Loeske	+	+	+	+
Loeskypnum badium (Hartm.) Paul	+	+	+	+
Sanionia uncinata (Hedw.) Loeske	+	+	+	+
Sarmentypnum sarmentosum (Wahlenb.) Tuom. et T.Kop.		+	+	+
Scorpidium scorpioides (Hedw.) Limpr.	+	+	+	+
Warnstorfia exannulata (Guemb. in B.S.G.) Loeske	+	+	+	+
W. fluitans (Hedw.) Loeske	+	+	+	+
W. h-schulzei (Limpr.) Loeske		+		
W. procera (Ren. et H. Arn.) Tuom.			+	+
W. pseudostraminea (C.Muell.) Tuom. et Kop.			+	+
W. trichophylla (Warnst.) Tuom. et Kop.			+	+
Brachytheciaceae				
Brachythecium albicans (Hedw.) Schimp. in B.S.G.		+	+	+
B. campestre (C.Muell.) Schimp. in B.S.G.			+	
B. erythrorrhizon Schimp. in B.S.G.		+		
B. oedipodium (Mitt.) Jaeg.		+	+	+

Families and species		1	2	3	4
B. populeum (Hedw.) Schimp. in B.S.G.			+		
B. reflexum (Starke in Web. et Mohr) Schimp. in B.S.G.		+	+	+	+
B. rivulare Schimp. in B.S.G.			+	+	+
B. rutabulum (Hedw.) Schimp. in B.S.G.				+	
B. salebrosum (Web. et Mohr) Schimp. in B.S.G.		+	+	+	+
B. starkei (Brid.) Schimp. in B.S.G.				+	+
Cirriphyllum piliferum (Hedw.) Grout			+		
Eurhynchium pulchellum (Hedw.) Jenn.			+		
E. striatulum (Spruce) Schimp. in B.S.G.					+
Isothecium myosuroides Brid.			+		+
Tomentypnum nitens (Hedw.) Loeske			+	+	+
Plagiotheciaceae					
Plagiothecium denticulatum (Hedw.) Schimp. in B.S.G.		+	+	+	+
P. laetum Schimp. in B.S.G.			+	+	+
P. nemorale (Mitt.) Jaeg.					+
Hypnaceae					
Callicladium haldanianum (Grev.) Crum		+	+	+	
Herzogiella turfacea (Lindb.) Iwats.		+	+		
Hypnum cupressiforme Hedw.		+	+		
H. lindbergii Mitt.		+	+	+	+
H. pallescens (Hedw.) P.Beauv.			+	+	+
Isopterygiopsis pulchella (Hedw.) Iwats.			+		
Platygyrium repens (Brid.) Schimp. in B.S.G.			+		
Pseudotaxiphyllum elegans (Brid.) Iwats.				+	
Ptilium crista-castrensis (Hedw.) De Not.		+	+	+	+
Pylaisiella polyantha (Hedw.) Grout			+	+	+
Hylocomiaceae					
Hylocomiastrum pyrenaicum (Spruce) Fleisch. in Broth.					+
Hylocomiastrum umbratum (Hedw.) Fleisch. in Broth.				+	
Hylocomium splendens (Hedw.) Schimp. in B.S.G.		+	+	+	+
Pleurozium schreberi (Brid.) Mitt.		+	+	+	+
Rhytidiadelphus squarrosus (Hedw.) Warnst.		+	+	+	+
R. subpinnatus (Lindb.) T.Kop.			+		+
R. triquetrus (Hedw.) Warnst.		+	+	+	+
Totally:	236	82	196	152	175

Classification of mire vegetation

No biodiversity assessment of plant communities is possible without some system of classification. Several methods of plant cover classification are used in different countries. These concentrate on physiognomic, ecological–floristic and topological characteristics respectively (Aleksandrova 1969, Rybnicek, 1985, Moen 1990). We use the ecological–floristic method commonly applied to the classification of mire communities in many countries. Classifications are made at four levels, each syntaxon including a group of diagnostic species and the name of the author who has described it for the first time.

The ecological–floristic classification of the mire communities of Karelia (Kuznetsov 1998) includes 36 associations belonging to 12 alliances, 9 orders and 5 classes. Several associations have been classified for the first time and have not yet been officially published. Some associations are divided into sub-associations and faciations, most of which also appear for the first time.

The plant communities occurring on the mires of the proposed Kalevala National Park were classified into 23 associations, with all 5 classes represented (Table 2). Most associations and sub–associations found in the park are of widespread occurrence throughout Karelia and Fennoscandia. However, some syntaxa occur which are rare for Karelia. The association *Calamagrostio canescentis – Piceetum abies* ass.nova contains mesoeutrophic spruce mire communities with a field layer composed of tall herbs. It is found at sites of plentiful ground water. These generally occur on the margins of mires. Similar communities with pine in the wood layer are attributed to *Calamagrostio canescentis – Pinetum sylvestris* ass.nova. The association *Caricetum* diandrae Jonas 32 em. Oberd. 57 occurs in small sites where ground water discharges, or along brooks and small rivers. The few plant communities of the alliance *Sphagno warnstorfiani – Tomentypnion* (class *Scheuchzerio – Caricetea nigrae*) are confined to the richer habitats of the park. Most mires are dominated by herb (grass) –*Sphagnum* and herb communities of the *Scheuchzerietalia palustris* order (class *Scheuchzerio – Caricetea nigrae*), which are attributed to 11 associations.

Most of the associations include a number of sub–associations distinguished with respect to dominant mosses. Each of these associations is of widespread occurrence in Scandinavia. However, some sub–associations have not been previously recorded (Dierssen 1982, Boch & Smagin 1993). We have identified sub–associations of *Sphagnum pulchrum* and *S.jensenii* within several associations (Table 2). The species composition of plant communities (Table 3) is presented in accordance with the classification of ecological groups of species used for identifying the syntaxa of mire vegetation in Karelia (Kuznetsov 1993). There are very few communities with moss layers of *Sphagnum platyphyllum*. We have, therefore, given these the status sub–association provisorius (Table 3). Plant communities with a predominance of *Spagnum fallax* in the ground layer are widespread throughout the park (Table 3).

Table 2. List of mire plant communities (associations and subassociations) which are recorded (+), hypothetically available (?) and absentees (-) on existing and planned nature protected territories (NPT) in the regions of Karelia adjacent to the Finnish-Russia border

A - NP Paanajärvi, B - planned NP Kalevala, C- Kostamus state nature reserve, D - planned NP Tuulos, E - landscape reserve Tolvajärvi, F - planned NP Koitajoki, G - whole territory adjacent to the Finnish-Russia border

syntaxa	A	B	C	D	E	F	G
Class **Alnetea glutinosae Br. - Bl et Tx 43**							
Order **Alnetalia glutinosae Tx. 37**							
Alliance **Alnion glutinosae Muller et Gors 58**							
1. Association Alnetum glutinosae - Sphagnosum Schwickerath 44	–	–	–	–	–	–	?
Order **Calamagrostio canescentis - Piceetalia** abies Solometch 94							
Alliance **Crepido paludosae - Piceenion abietis** Solometch 94							
2. Ass. Calamagrostio canescentis - Piceetum abies ass. nova	+	+	+	?	?	?	+
Facium: typicum							
Phragmites australis							
3. Ass. Calamagrostio canescentis - Pinetum sylvestris ass. nova	?	+	+	+	?	?	+
4. Ass. Phragmito - Betuletum pubescentis Bulîchov 91	?	–	–	–	–	–	+
Class **Phragmiti - Magnocaricetea Klika in Klika et** Novak 41							
Order **Phragmitetalia australis Pignatti 54**							
Alliance **Phragmition australis Koch 25**							
5. Ass. Phragmitetum australis Koch 25 Subassociation comaretosum palustris	?	–	–	–	–	–	+
Order **Magnocaricetalia Pignatti 54**							
Alliance **Magnocaricion Koch 25**							
6. Ass. Caricetum acutae Tx. 37	–	–	?	?	+	+	+
7. Ass. Caricetum cespitosae Palczynski 75	+	+	+	+	+	+	+
8. Ass. Caricetum omskianae ass. Mova	–	–	–	–	–	–	?
9. Ass. Equisetetum fluviatilis Matuszkiewicz 84	+	+	+	+	+	+	+
Class **Scheuchzerio - Caricetea nigrae (Nordh. 36) Tx. 37**							
Order **Caricetalia nigrae Nordh. 36**							
Alliance **Naricion nigrae Koch 25**							
10. Ass. Caricetum diandrae Jonas 32 em. Oberd. 57	?	+	?	–	–	–	+
Order **Scheuchzerietalia palustris Nordh. 36**							
Alliance **Caricion lasiocarpae Vanden Bergen in** Lebrum et all. 49							
11. Ass. Caricetum lasiocarpae Osvald 23 em.Diers - sen 82	+	+	+	+	+	+	+
Subass. typicum	+	+	+	+	+	+	+

syntaxa	A	B	C	D	E	F	G
Subass. comaretosum palustris	+	+	+	?	?	+	+
Subass. scorpidietosum scorpioidi	+	+	?	–	–	–	+
Subass. warntorfietosum exannulati	+	+	+	–	–	–	+
Subass. hamatocaulietosum vernicosi	–	–	–	–	–	–	?
Subass. Sphagnetosum subsecundi	+	+	+	+	+	+	+
Subass. campylietosum stellati	+	?	–	–	–	–	+
12. Ass. Caricetum rostratae Osvald 23 em. Diers-sen 82	+	+	+	+	+	+	+
13. Ass. Caricetum chordorrhizae Paul et Lutz 41	+	–	–	–	–	–	+
14. Ass. Caricetum limosae Osvald 23 em. Diers-sen 82	+	+	+	+	+	+	+
Subass. typicum	+	+	+	+	+	+	+
Subass. scorpidietosum scorpiodi	+	?	?	?	–	–	+
Subass. warnstorfietosum exannulati	+	+	+	?	–	–	+
Subass. sphagnetosum subsecundi	+	+	+	+	+	+	+
15. Ass. Caricetum lividae Nordh. 28	+	–	–	–	–	–	+
Subass. typicum	+	–	–	–	–	–	+
Subass. scorpidietosum scorpioidi	+	–	–	–	–	–	+
16. Ass. Carici lasiocarpae - Sphagnetum fallacis Waren 26 em. Rybnicek 84	+	+	+	+	+	+	+
Subass. sphagnetosum angustifolii	+	+	+	+	+	+	+
Subass. sphagnetosum papillosi	+	+	+	+	+	+	+
Subass. sphagnetosum fallacis	+	+	+	+	+	+	+
Subass. sphagnetosum flexuosii	–	–	+	–	–	+	+
Subass. sphagnetosum centralis	+	+	–	–	–	–	+
Subass. sphagnetosum pulchrii	–	+	+	–	–	–	+
Subass. sphagnetosum obtusii	–	–	?	–	–	–	?
Subass. sphagnetosum baltici	+	+	+	?	+	?	+
Subass. sphagnetosum majii	+	+	?	?	+	+	+
17. Ass. Carici rostratae - Sphagnetum fallacis Osvald 23 em. Rybnicek 84	+	+	+	+	+	+	+
Ass. Sphagnetosum angustifolii	+	+	+	+	+	+	+
Subass. sphagnetosum fallacis	+	+	+	+	+	+	+
Subass. sphagnetosum flexuosii	–	?	–	–	–	–	?
Subass. sphagnetosum papillosi	+	+	+	+	+	?	+
Subass. sphagnetosum baltici	+	+	+	+	–	+	+
Subass. sphagnetosum majii	+	+	+	?	+	+	+
Subass. sphagnetosum jensenii	+	+	+	+	–	+	+
Subass. sphagnetosum lindbergii	+	+	+	?	–	+	+
18. Ass. Menyantho - Sphagnetum fusci Blagoves-chenskiyi 36 em. Boc 90	+	+	+	+	+	+	+
19. Ass. Molinio caerulei - Sphagnetum papillosi ass. nova	+	+	+	+	?	+	+
Facium: Molinia caerulea							
Baeothryon alpinum							
Baeothryon cespitosum							

syntaxa	A	B	C	D	E	F	G
Alliance **Rhynchosporion albae Koch 26**							
20. Ass. Scheuchzerio palustris - Sphagnetum cuspidati Osvald 23	+	+	+	+	+	+	+
Subass. sphagnetosum baltici	+	+	+	+	+	+	+
Facium: Scheuchzeria palustr							
Carex limosa							
Subass. sphagnetosum majii	+	+	+	+	+	+	+
Facium: Scheuchzeria palustris							
Carex limosa							
Subass. sphagnetosum papillosi	+	+	+	+	+	+	+
Facium: Scheuchzeria palustris							
Carex limosa							
Subass. sphagnetosum lindbergii	+	+	+	+	?	?	+
Facium: Scheuchzeria palustris							
Carex limosa							
Subass. sphagnetosum cuspidatii	–	–	–	–	–	–	–
Subass. sphagnetosum fallacis	+	+	+	+	+	+	+
Subass. sphagnetosum flexuosii	–	–	–	–	–	–	–
Subass. sphagnetosum pulchrii	–	+	+	+	?	?	–
Subass. sphagnetosum jensenii	–	+	+	–	+	+	+
Ass. Eriophoro vaginati-Sphagnetum baltici Bogdanowskaya-Guieneuf 28 em.Kuznetsov 91	+	+	+	+	+	+	+
Subass. sphagnetosum baltici	+	+	+	+	+	+	+
Facium: Eriophorum vaginatum							
Baeothryon cespitosum							
Subass. sphagnetosum majii	?	+	+	?	+	+	+
Facium: Eriophorum vaginatum							
Baeothryon cespitosum							
Subass. sphagnetosum papillosi	+	+	+	+	+	+	+
Subass. sphagnetosum lindbergii	+	+	+	+	?	?	+
Subass. sphagnetosum fallacis	+	+	+	+	+	+	+
Subass. sphagnetosum flexuosii	–	–	–	–	–	–	?
Subass. sphagnetosum cuspidati	–	–	–	–	+	–	+
Subass. sphagnetosum compacti	–	–	+	–	+	–	+
22. Ass. Sphagno - Rhynchosporetum albae Osvald 23 em. Koch 26	–	–	–	–	+	+	+
Subass. sphagnetosum baltici	–	–	–	–	–	+	+
Subass. sphagnetosum majii	–	–	–	–	–	+	+
Subass. sphagnetosum papillosi	–	–	–	–	–	+	+
Subass. sphagnetosum cuspidatii	–	–	–	–	–	–	–
23. Ass. Hepatico - Rhynchosporetum albae Bogdanowskaya-Guieneuf 28 em. Boch 92	+	+	+	+	+	+	+
24. Ass. Rhynchosporetum fuscae W. Braun 68	–	–	–	–	–	–	?
25. Ass. Eriophoretum angustifolii Osvald 23	+	+	+	+	+	+	+
Order **Caricetalia davallianae Br.-Bl. 49**							
Alliance **Caricion davallianae Klika 34**							
26. Ass. Trichophoro - Schoenetum ferruginei (Booberg 30) Gors 64	+	–	–	–	–	–	+
Subass. molinietosum caerulei subass. nova	+	–	–	–	–	–	+

syntaxa	A	B	C	D	E	F	G
Alliance **Sphagno warnstorfiani - Tomenthypnion Dahl 57**							
27. Ass. Sphagno warnstorfiani - Caricetum lasio-							
carpae Steffen 31 em. Rybnicek 74	+	+	+	+	–	–	+
GSubàss. typicum	+	+	+	?	–	–	+
Facium: Carex lasiocarpa							
Phragmites australis							
Subass. sphagnetosum teresi	+	?	?	–	–	–	+
Subass. sphagnetosum subfulvii	+	+	+	–	–	–	+
28. Ass. Sphagno warnstorfii - Molinietum caerulei							
ass. nova	+	+	+	+			+
Subass. typicum	+	+	+	?	–	–	+
Facium: Molinia caerulea							
Baeothryon cespitosum							
Baeothryon alpinum							
Subass. sphagnetosum subfulvii	+	+	+	+	–	–	+
29. Ass. Sphagneto warnstorfii - Equisetetum palu-							
stris ass. nova	+	?	+	–	–	–	+
Subass. typicum	+	?	+	–	–	–	+
Facium: Polygonum bistorta							
Equisetum palustris							
Subass. tomentypnetosum nitensi	+	–	–	–	–	–	+
30. Ass. Sphagno warnstorfii - Pinetum sylvestris							
(Smagin 91) em. Kuznetsov 97	+	–	–	–	–	–	+
Facium: Phragmites australis							
Carex lasiocarpa							
Molinia caerulea							
Class **Oxycocco - Sphagnetea Br.- Bl. et Tx. 43**							
Order **Sphagnetalia magellanici (Pawl. 28)**							
Kastner et Flossner 33							
Alliance **Oxycocco - Empetrion hermaphroditi Nordh 36**							
31. Ass. Chamaedaphno - Sphagnetum fusci Solo-							
metch 94	+	+	+	+	+	+	+
Facium: Chamaedaphne calyculata							
Rubus chamaemorus							
Empetrum nigrum							
Andromeda polifolia							
Eriophorum vaginatum							
32. Ass. Chamaedaphno - Sphagnetum magellanici							
Bogdanowskaya - Guieneuf 28 em. Boc 90	+	+	+	+	+	+	+
Facium: Chamaedaphne calyculata							
Eriophorum vaginatum							
33. Ass. Calluno vulgaris - Cladinetum Bogdanow-							
skaya - Guieneuf 28 em. Kuznetsov 91	–	?	?	+	+	+	+

syntaxa	A	B	C	D	E	F	G
Class **Vaccinietea uliginosi Tx. 55**							
Order **Vaccinietalia uliginosi Tx. 55**							
Alliance **Chamedaphno - Pinion Solometch 94**							
34. Ass. Chamaedaphno calyculata - Ledetum palustris Korotkov 91	+	+	+	+	+	+	+
Subass. sphagnetosum fusci	+	+	+	+	+	+	+
Subass. sphagnetosum angustifolii	+	+	+	+	+	+	+
35. Ass. Carici lasiocarpae - Pinetum sylvestris ass. nova	+	+	+	+	+	+	+
Subass. sphagnetosum angustifolii	+	+	+	+	+	+	+
Subass. sphagnetosum fallacis	+	+	+	+	+	+	+
Subass. sphagnetosum flexuosii	–	–	–	–	–	–	?
Subass. sphagnetosum centralis	+	?	?	–	–	–	+
Alliance **Betulion pubescentis Tx. 55**							
36. Ass. Narici lasiocarpae - Betuletum pubescentis ass. nova	+	+	+	?	?	?	+
Subass. sphagnetosum angustifolii	+	+	+	?	?	?	+
Subass. spagnetosum centralis	?	?	–	–	–	–	?

Table 3. Species composition (degree of coverage, %) of the communites with a dominance of Sphagnum platyphyllum (I), S. jensenii (II), S. pulchrum (III) and S. fallax (IV).

	I			II			III Subassociations*					IV						
Ecological groups of mire	A		B	C	D		E	F releves**			G		H			I		K
	1	6	4	35	34	36	35	1	2	3	36	5	14	16	17	18	19	33	7
	total number of species																		
	12	6	15	15	11	10	19	9	11	9	13	14	36	28	33	17	12	10	10
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Picea abies													+	+	+				
Pinus sylvestris													7	1	+	+			
Betula pubescens													3	5	13	+			
Ledum palustre																			
Ledum palustre													2	1					
Vaccinium uliginosum													+	1	1				
Empetrum nigrum																			
Empetrum nigrum													1	+					
Drosera rotundifolia	+				1			+	+	+			+						
Chamaedaphne Calyculata																			
Chamaedaphne calyculata													+	3	+		+		+
Betula nana			+				3	20	15	15		2		10	2	+		1	1
Andromeda polifolia			5	+	10	+	1	+	+	1	2	2	10	+	2	+	2	1	+
Oxycoccus palustris				+	10		2				1	5	1	2	1	+	1	2	+
Eriophorum vaginatum							+				+		3	5	+	+	10	2	
Carex pauciflora													1	1		20	20	2	
Sphagnum angustifolium															5		10		
S. magellanicum	+				+		+	5	5	5				15		+			

releves**

	1	6	4	35	34	36	35	1	2	3	36	5	14	16	17	18	19	33	7
Carex limosa																			
Carex limosa	10	10	5	+	5	20	+				5	5	+		+	+	5	5	+
Baeothryon cespitosum		+						5	5	2			1						
Scheuchzeria palustris	20	30		+	15	10	+				1	5	+			+		10	40
Drozera anglica	+		+																
Sphagnum jensenii	10	10	25	+	100	20	40				30								
Carex lasiocarpa																			
Carex lasiocarpa	5		1	25			25	5	5	3		10	5	15	15		+		
C. rostrata	2		5	2	1	5	3				20	+	3	3	5	15	10	10	
C. echinata													1	+	1				
Sphagnum fallax												100	50	70	70	100	90	100	100
S. pulchrum				+			10	95	95	90	65								
S. centrale				+			10				5				10				
Baeothryon alpinum																			
Salix myrtilloides							+						1		2				
Molinia caerulea													3						
Carex dioica												+			+	15			
Aulacomnium palustris													+		+				
Carex livida																			
Juncus stygius			+						+										
Sphagnum subsecundum			10	10			30												
S. platyphyllum	80	90	55	20		10	+					+							
Menyanthes trifoliata																			
Menyanthes trifoliata			5	+	20	5	2				10		15	10	3	5	10	5	10
Eriophorum gracile														+	+				
E. polystachion		2										30		2	+	5	5		1

releves**

	1	6	4	35	34	36	35	1	2	3	36	5	14	16	17	18	19	33	7
Carex chordorrhiza	10		5	2	+	5	2	5	5	2	10	2	2	+	2	1			
Equisetum fluviatile			15	1	1	2	2					20	1	2	1	+			
Utricularia intermedia	5		20	1		2													
Calla palustris																			
Calamagrostis purpurea													+		1				
Carex magellanica													1	+					
Calamagrostis neglecta																			
Salix lapponum													+	+	5				
S. phylicifolia													+	+	7				
Comarum palustre								1	1	+	+				2				
Forests species																			
Juniperus communis														+	1				
Sphagnum russowii													+	10	5				+

Once found: releve 1 - Sphagnum subfulvum (5%), 2 - Carex livida (+), 4 - Eriophorum latifolium (5), 14 - Corallorhiza trifida (+), Calestania palustris (2), Calestania palustris (2), Trientalis europaea (+), Sphagnum papillosum (10), Viola epipsola (1), 16 -Polytrichum commune (5), Sphagnum angstroemii (+), 17 -Equisetum palustre (+), Rubus arcticus (+), Viola palustris (+), Vaccinium vitis-idaea (+), 35 -35 - Calliergon stramineum (+).

* Association Carici lasiocarpae-sphagnetum fallacis, subassociations: sphagnetosum platyphyllii (C), sph. jensenii (E), sph. pulchrii (F), sph. fallacis (H); Ass. Carici rostratae - Sphagnetum fallacis, subass.: sph. platyphyllii (B), sph. pulchrii (G), sph. fallacis (I); Ass. Scheuchzerio palustris - Sphagnetum cuspidati, subass.: sph. platyphyllii (A), sph. jensenii (D), sph. fallacis (K).

** Releves: 1, 2, 3, 4, 5, 6, 7, 14 – mire Latvasuo; 16, 17, 18, 19 – Stansuo; 33, 34, 35, 36 – Vasensuo.

Mire systems, their structure, stratigraphy and genesis

The mires of the proposed Kalevala National Park are generally confined to narrow elongated depressions occurring between hills, along rivers and adjoining lakes. Complex mire systems are predominant throughout the whole of the park territory. These complexes were formed by a number of separate mire massifs which grew in size during the Holocene epoch. Today mires occupy 40–60 % of the western part of the proposed park and 20–30 % of its eastern part, this latter containing a greater degree of dissected relief.

Mire systems are composed of mire massifs of various types and genesis. These systems cover hundreds of hectares. Most mire systems comprise complex, irregular units including mineral islets, remnant water bodies, brooks and paludified forests. In some cases the various elements of a mire system lie at different levels. The park area includes sloping fens affected by groundwater. The maximum peat deposit thickness varies between one and six metres. Many of the mires are of limnic genesis and there is often a three metre thick layer of sapropel at the deepest point.

Most of the mires in the area are minerotrophic, that is, they are affected by the presence of groundwater. Ombrotrophic mires are rare. Small ombrotrophic mire sites are encountered generally on the margins of mires and occasionally in their central parts. Minerotrophic mires and mire sites are supplied with ground water deficient in nutrients and are consequently meso–oligotrophic (oligotrophic, according to the typology of Eurola et al. 1984). Most of the mires belong to the mesotrophic grass–*Sphagnum* type (Yurkovskaya 1980, Elina et al. 1984). At the central parts their plant cover are made up of various grass–*Sphagnum* communities. The characteristics of the main communities (associations) found are given below. Mire margins are occupied by woody–*Sphagnum* communities of varying nutrient status. We do not consider all minerotrophic mires to be of the aapa mire type. Mires with *Sphagnum* communities and a surface pattern of low flarks and hummocks are developing towards ombrotrophy and are therefore not included in the aapa category (Kuznetsov 1982). Typical aapa mires with well developed flark and string patterning are few in the area. Ombrotrophic pine–dwarf shrub–*Sphagnum* mires, *Sphagnum* ridge–hollow mires and paludified forests with a thin peat layer (< 30 cm) are also represented within the mire systems studied.

It is very difficult to distinguish between forested mires and paludified forests because the transitions from one to the other are very gradual and thus the boundaries are indistinct. Generally speaking, paludified forests in the denudation-tectonic landscapes of north-taiga Karelia account for 10–30 % of the total paludified area (Volkov et al. 1995). Paludified spruce (horsetail–*Sphagnum*, bilberry–*Sphagnum*, sedge–*Sphagnum*) and pine (marsh rosemary–*Sphagnum*, sedge–*Sphagnum*) forests are widespread in Kalevala park. According to Finnish classifications paludified forests are not treated separately but are included in the various classes of mires. Thus, paludified pine woods are called 'räme' and paludified spruce forests 'korpi' (Eurola et al. 1984, Ruuhijärvi 1988).

Mesotrophic and meso–eutrophic mires occur in areas where ground water wedges out along the banks of rivers and shores of lakes. Their plant cover is formed by sedge, woody-herb and woody–grass–moss communities with a predominance of *Betula pubescens, Carex lasiocarpa, C. cespitosa,* and *C. rostrata*, with some willows (*Salix lapponum, S.phylicifolia*) (Table 3).

Studies of the genesis and dynamics of certain typical mire systems within the proposed park were based on stratigraphic materials.

The Latvasuo mire system lies on the eastern shore of lakes Keski– and Ylä–Latvajärvi (Fig. 3, 4) and covers an area of about 150 ha. It takes the form of a number of kettle holes which discharge into the lakes and are separated by chains

of mineral islands. The mire system is composed of mire massifs of the aapa and mesotrophic herb–*Sphagnum* types. At the present time the central part of the mire consists of mesotrophic stringflark mire sites. The string vegetation is formed by herb–*Sphagnum* communities (Ass. *Carici lasiocarpae–Sphagnetum fallacis, Molinio caerulei–Sphagnetum papillosi*) while the plant cover of flarks consists of herb and herb–*Sphagnum* coenoses (Ass. *Caricetum limosae, Scheuchzerio palustris–Sphagnetum cuspidati*). In flark communities grow two rare plant species: *Carex livida* and *Sphagnum pulchrum*. Together with aapa complexes, the herb–*Sphagnum* and woody–herb–*Sphagnum* communities *Carici rostratae–Sphagnetum fallacis, Carici lasiocarpae–Pinetum sylvestris* and *Chamaedaphno calyculata–Ledetum palustris* are common on the mire.

Differences were found between the vegetation dynamics of two kettle hole mires lying along the stratigraphic profile (Fig. 4, II). The shore lake depression (Fig. 4, borehole 12) with its 5.2 metre thick peat deposit was originally a shallow bay of the lake where a horsetail–*Hypnum* community flourished (Fig. 5, palaecommunity (PC) I. As the lake retreated and peat accumulated, eutrophic sedge–*Sphagnum* communities with *Paludella squarrosa* and *Tomentypnum nitens* (PC) II developed. Relatively good drainage led to the development of birch–sedge commu-

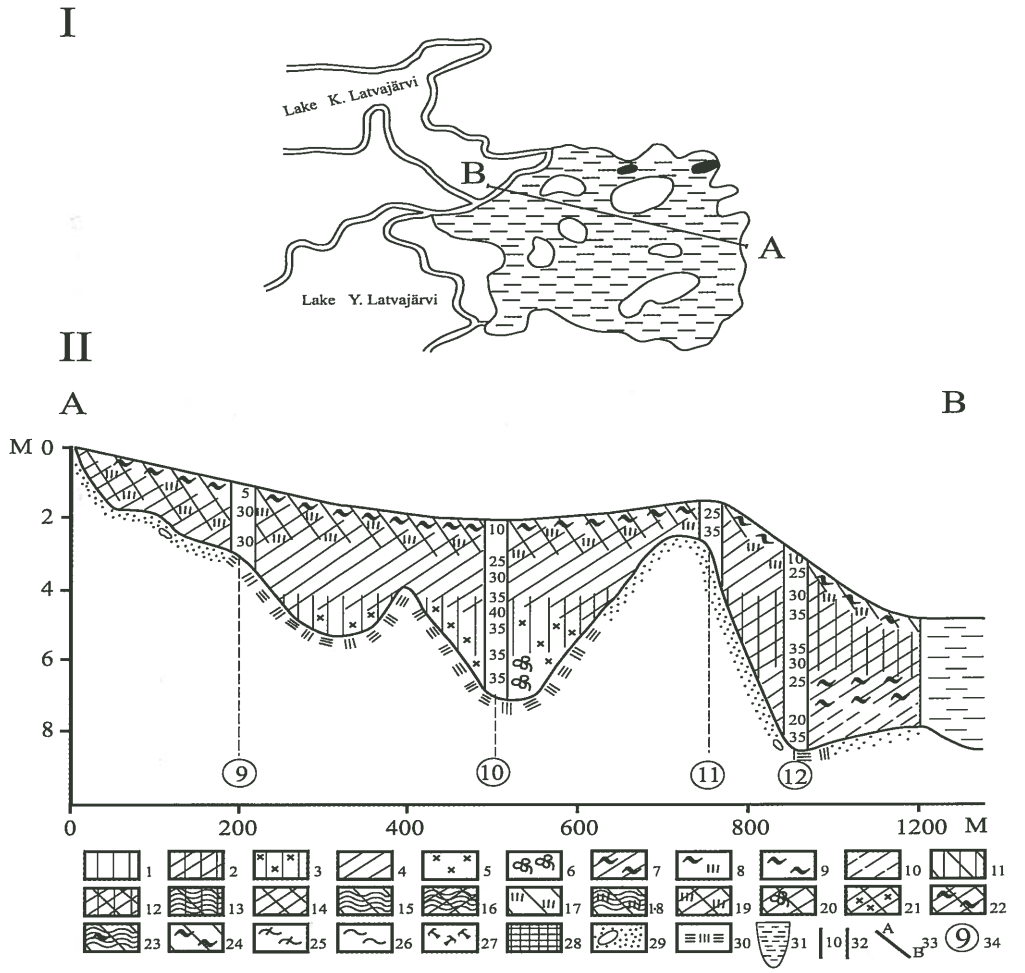

Fig. 4. Plan-scheme (I) and stratigraphic profile (II) of Latvasuo.Symbols for stratigraphic profiles: Eutrophic peat (1-10): 1-woody, 2- woody-sedge, 3- woody-horsetail, 4- sedge, 5- horsetail, 6- bogbean, 7- Sphagnum-sedge, 8- Sphagnum-Scheuchzeria, 9- Sphagnum, 10- hypnum (Bryales; mesotrophic peat (11-24): 11- woody, 12- woody-sedge, 13- woody-cottongrass, 14- sedge, 15- cottongrass, 16- sedge-cottongrass, 17- Scheuchzeria, 18- Scheuchzeria-cottongrass, 19- Scheuchzeria-sedge, 20- sedge-bogbean, 21- sedge-horsetail, 22- Sphagnum-sedge, 23- Sphagnum-cottongrass, 24- Sphagnum; ombrotrophic peat (25-26): 25- fuscum, 26- Sphagnum hollow. 27- peat (undetermines, 28- gyttia (sapropel), 29- till, 30- clay, 31- open water, 32- degree of decomposition (%), 33- stratigraphic profile, 34- peathole (borehole) number.

nities (PC) III. They dominated for a long period and deposited a three metre thick layer of birch–sedge peat. During the past millennium they have given way to mesotrophic sedge–*Sphagnum* (*Carex rostrata–Sphagnum fallax*) coenoses (PC) IV.

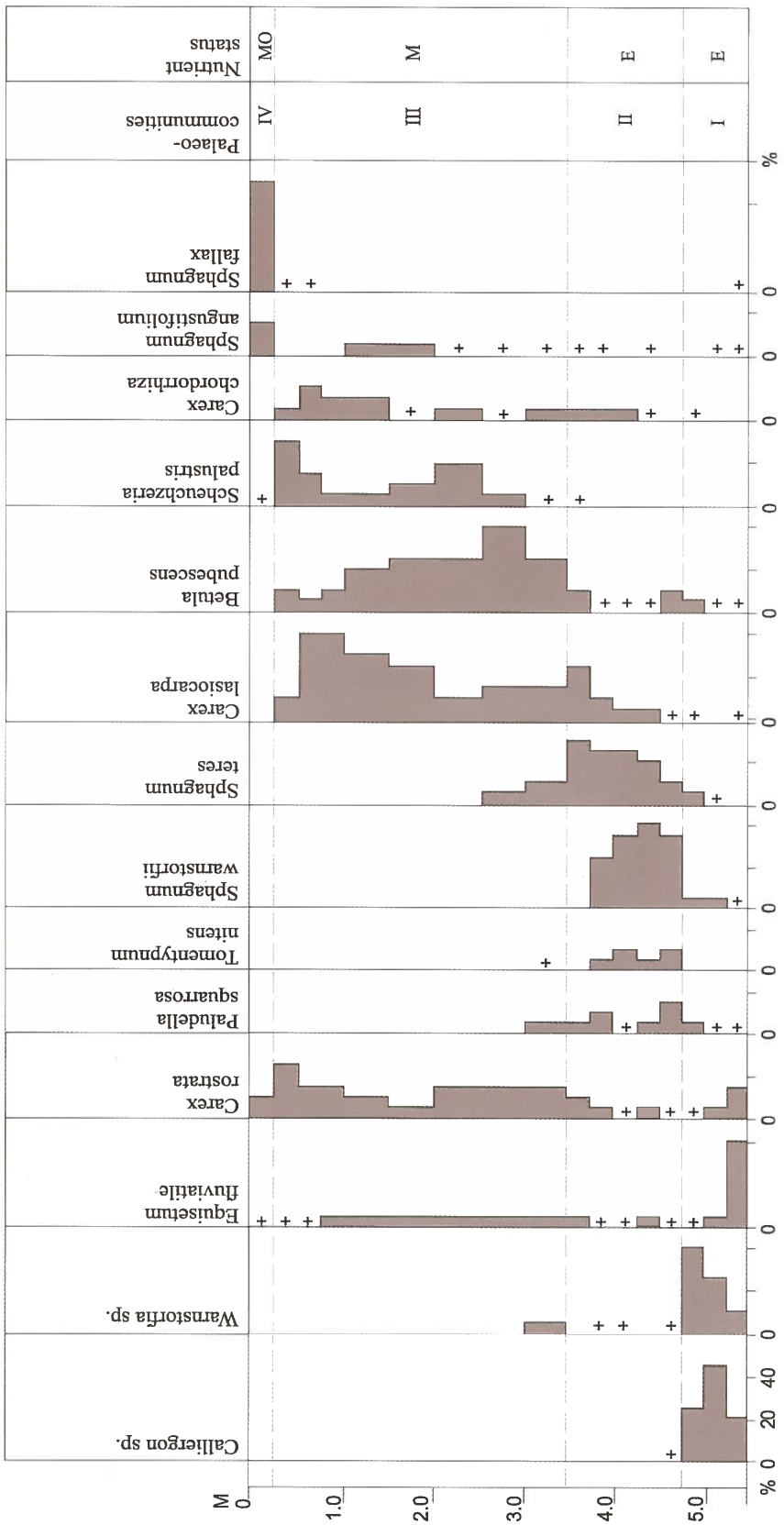

Fig. 5. Macrofossil diagram of Latvasuo (peathole 12). Palaeocommunities: I- Equisetum fluviatile - Calliergon sp. + Warnstorfia sp., II- Carex rostrata - Sphagnum warnstorfii + S. teres, III- Betula pubescens - Carex spp., IV- Carex rostrata - Sphagnum fallax. E- eutrophic, M- mesotrophic, MO- meso-oligotrophic.

The central kettle hole mire (Fig. 4, borehole 10) began to paludify with mesotrophic horsetail–bogbean communities (Fig. 6, PC I) that gave way quickly to birch–horsetail phytocoenoses (PC II), which in turn were succeeded by birch–sedge communities (PC III). When the water regime became more stagnant and the mineral nutrition of the mire deteriorated *Scheuchzeria*–sedge communities (PC IV) began to play a more important role. At the present time *Scheuchzeria* communities are being suppressed by *Sphagna* (PC V) and aapa complexes are forming.

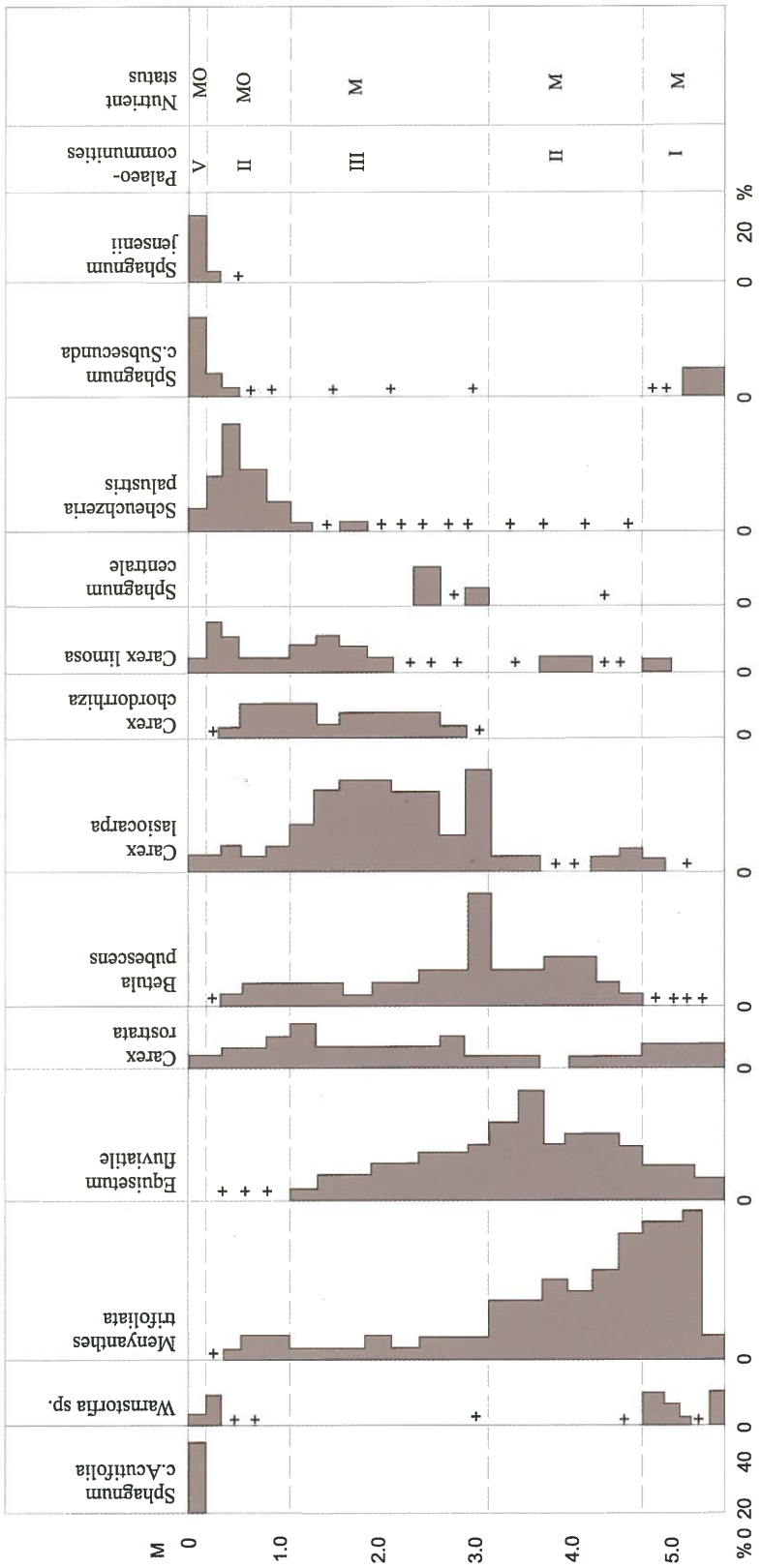

Fig. 6. Macrofossil diagram of Latvasuo (peathole 10). Palaeocommunities: I- Menyanthes trifoliata - Equisetum fluviatile. II- Betula pubescens - Equisetum fluviatile + Menyanthes trifoliata, III- Betula pubescens - Carex lasiocarpa, IV- Scheuchzeria palustris - Carex spp., V- Scheuchzeria palustris - Carex spp. - Sphagnum spp.

The Stansuo mire system is about 50 ha in size. It is located one kilometre north from Latvasuo mire (Fig. 7) and consists of a narrow mire massif along a brook, characterised by a great diversity of herb–moss communities of differing trophic status and small mires lying on the slopes either side of the brook. There is also a small relict lake occurring along the stratigraphic profile (Fig. 7, II). The northern shore of lake indicates the absence of any limnic stage throughout the period of mire formation. Paludification began with the formation of sedge–herb–*Sphagnum* communities (Fig. 8, PC I, II). Quick changes in moisture and nutrient conditions led to the development of meso–oligotrophic communities with *Sphagnum fuscum* (PC III), the pine and birch dominated woody component of which formed later (PC IV). Nowadays the shore mire site is occupied by an ombrotrophic pine–dwarf shrub–*Sphagnum* community of recent genesis (PC V).

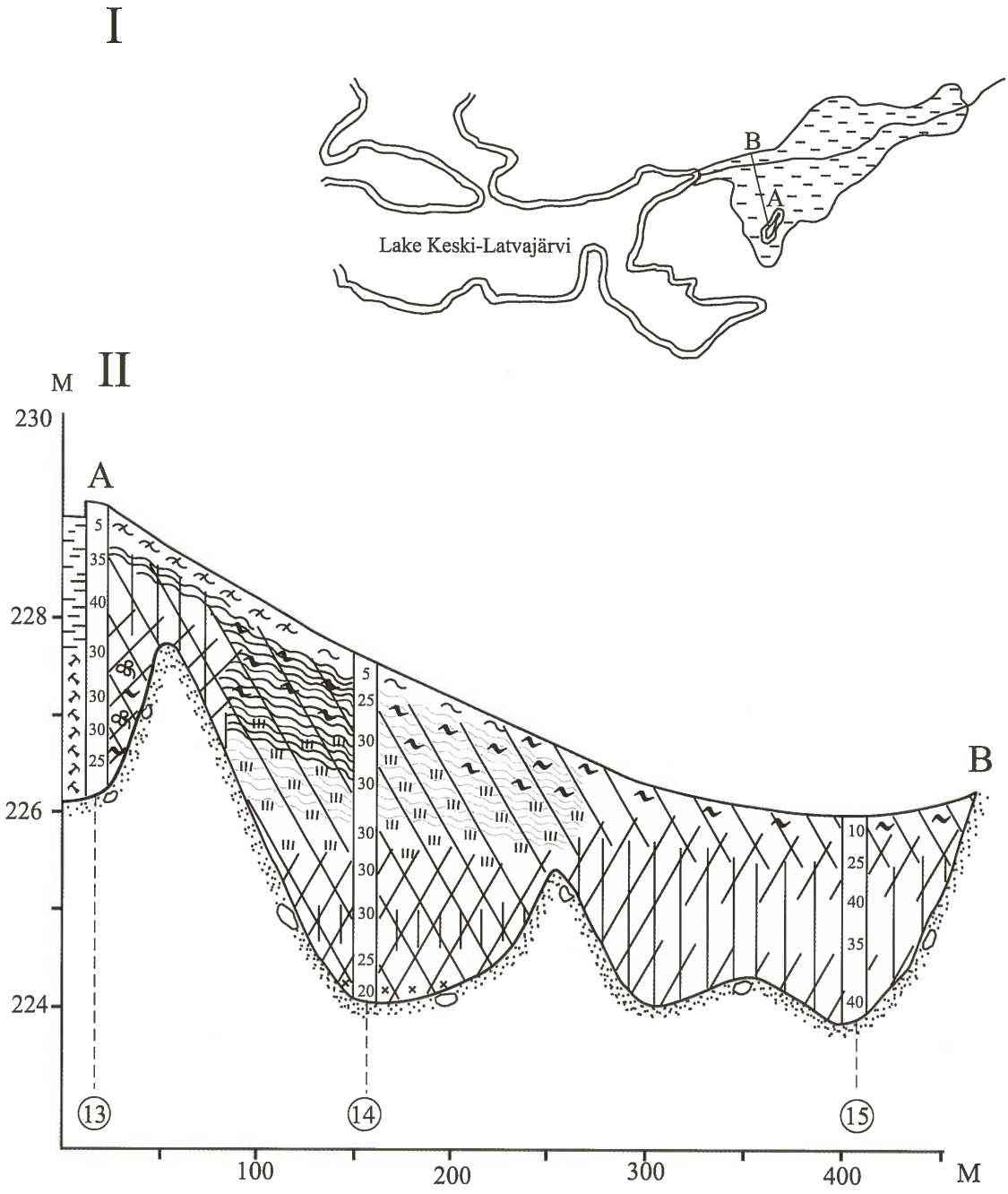

Fig. 7. Plan-scheme (I) and stratigraphic profile (II) of Stansuo. Symbols see on Fig. 6.

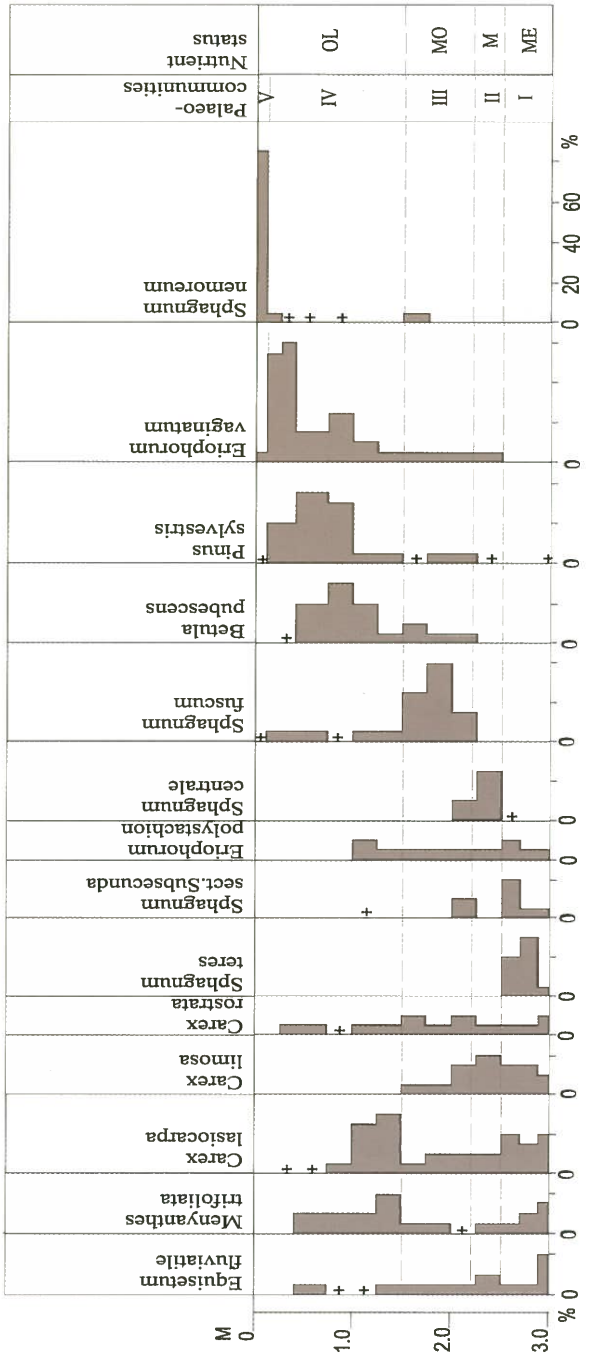

Fig. 8. Macrofossil diagram of Stansuo (peathole 13). Palaecommunites: I- Carex spp. - Menyanthes trifoliata-Sphagnum teres-S. sect. Subsecunda: II- Carex spp. -Sphagnum centrale; III- Carex spp.-Sphagnum fuscum; IV- Pinus sylvestris-Betula pubescens-Carex lasiocarpa-Eriophorum vaginatum-Sphagnum fuscum; V- Pinus sylvestrisa-Eriophorum vaginatum-Sphagnum nemoreum.

The sloping kettle hole mire (Fig. 7, borehole 14) is 3,2 metres in depth. Its terrestrialisation process began with the appearance of horsetail–*Hypnum* communities (PC I) (Fig. 9) which developed in the remnant shallow water body and deposited 10 cm of peat. This gave way quickly to a floating carpet of moss with *Sphagnum riparium* (PC II) and then to sedge communities (PC III). As the water regime grew more stagnant and the mineral nutrition of the mire deteriorated the mesotrophic sedge communities were succeeded by oligotrophic *Scheuchzeria* communities and then *Scheuchzeria*–cottongrass phytocoenoses (PC IV). The last millennium saw the formation of an ombrotrophic ridge–hollow bog with cottongrass–*Scheuchzeria*–*Sphagnum* hollows (PC V) and dwarf shrub–*Sphagnum (Sphagnum fuscum)* ridges. The recent nature of the ombrotrophic phase is confirmed by both the presence of sparse *Carex rostrata* in the hollows and its remains in the

uppermost peat layers. Along the brook and near to its mouth birch–sedge–*Sphagnum* communities (Ass. *Carici lasiocarpae-Betuletum pubescentis*) occur. The peat deposit is composed of woody, woody–sedge and sedge–*Sphagnum* peat (Fig. 7, borehole 15).

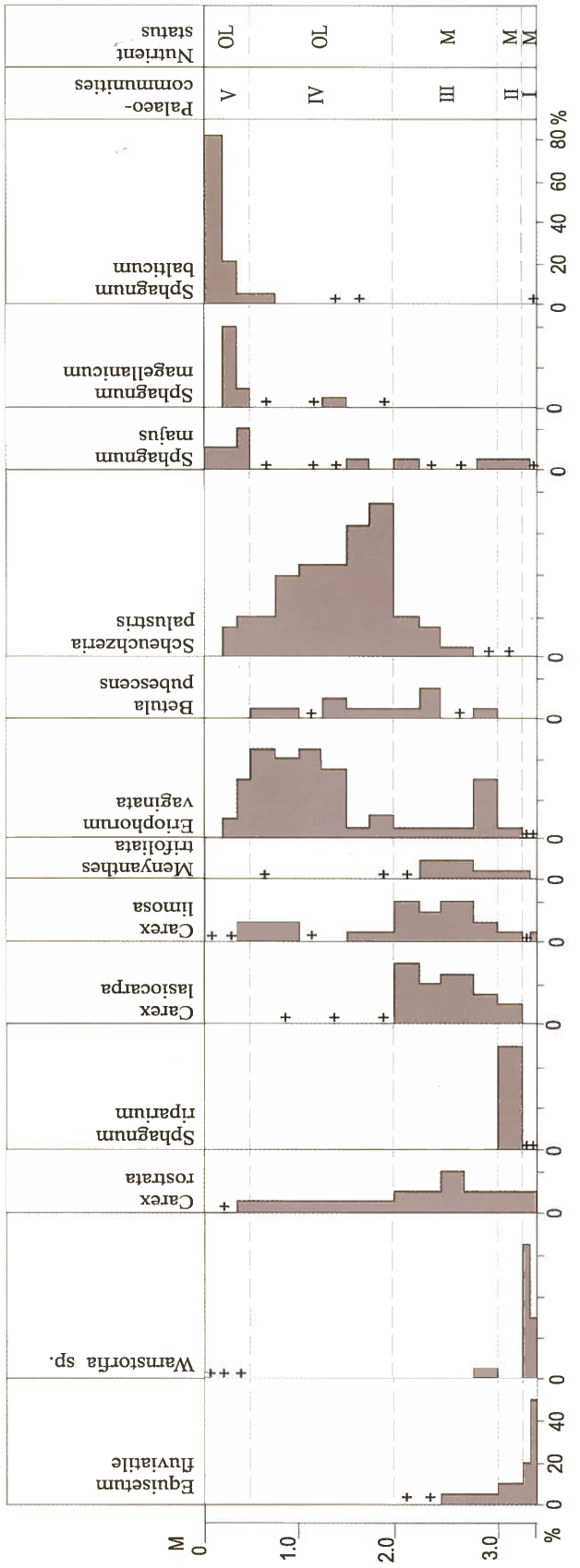

Fig. 9. Macrofossil diagram of Stansuo (peathole 14). Palaeocommunites: I- Equisetum fluviatile-Warnstorfia sp.; II- Carex spp.-Sphagnum riparium; III- Carex spp.; IV- Scheuchzeria palustris-Eriophorum vaginatum; V- Scheuchzeria palustris-Sphagnum balticum.

The Vasensuo mire system is situated 3 km west of Lake Ala–Latvajärvi (Fig. 3, 10) and has a total area of more than 200 ha. It is made up of kettle holes and slopes to the north of Vasenvaara Hill (258 metres above sea level). A wide band of mesotrophic and mesoeutrophic woody–herb–*Sphagnum* communities (Ass. *Carici lasiocarpae–Pinetum sylvestris, Carici lasiocarpae–Betuletum pubescentis, Calamagrostio canescentis–Pinetum sylvestris*) has formed at the foot of the northern slope of Vasenvaara Hill as a result of the discharge of groundwater. Narrower bands of plant communities composed of *Carex cespitosa, Calamagrostis purpurea, Sphagnum warnstorfii, Tomentypnum nitens and Bryum pseudotriquetrum* have developed around springs. The southern part of the mire system is several metres higher than its central area, which is taken up by mesotrophic and meso–oligotrophic grass – *Sphagnum* communities (Ass. *Carici rostratae–Sphagnetum fallacis, Scheuchzerio palustris–Sphagnetum cuspidati*). Cottongrass–*Sphagnum* coenoses (Ass. *Eriophoro vaginati–Sphagnetum baltici*) are well developed along slopes and margins. The same communities and their combinations (complexes) cover numerous narrow mire channels which link the mire system to others. On margins which are not affected by ground water pine–dwarf shrub–*Sphagnum* phytocoenoses (Ass. *Chamaedaphno calyculata–Ledetum palustris*) have formed.

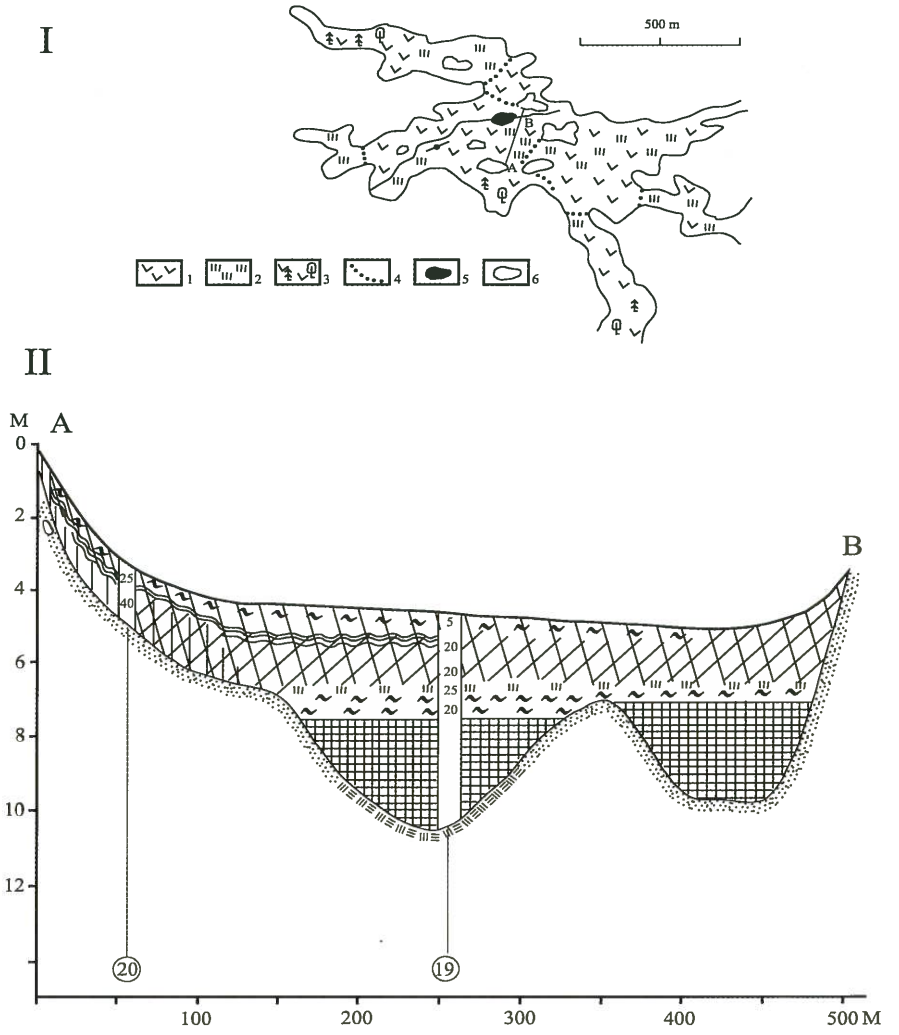

Fig. 10. Plant cover (I) and stratigraphic profile of Vasensuo (II). Mire sites (1-3): 1- mesooligotrophic sedge-Sphagnum; 2- oligotrophic Scheuchzeria-Sphagnum; 3- minerotrophic woody-herb (grass). 4- boundary of mire sites; 5- lake; 6- mineral islands. Symbols for profile see on Fig. 4.

Three metres thick layers of sapropel lying under the mire peat deposit (Fig. 10) and the remnant pond situated to the west of the profile are evidence of the limnic genesis of the mire. A stratigraphic column taken at the central part of the mire (borehole 19 in Fig.12, Fig.11) indicates that the overgrowing of the shallow water body began by bottom layer *Hypnum* communities (PC II) which gave way rather quickly to a bogbean–*Sphagnum* float (PC III). Reduced mineral nutrition and water stagnation led to the development of *Scheuchzeria*–sedge communities that persisted for a considerable length of time and deposited some two metres of peat (PC IV). Recently cottongrass–*Sphagnum* communities (PC V) have succeeded the herb (grass) communities, and the mire is developing towards an oligotrophic state.

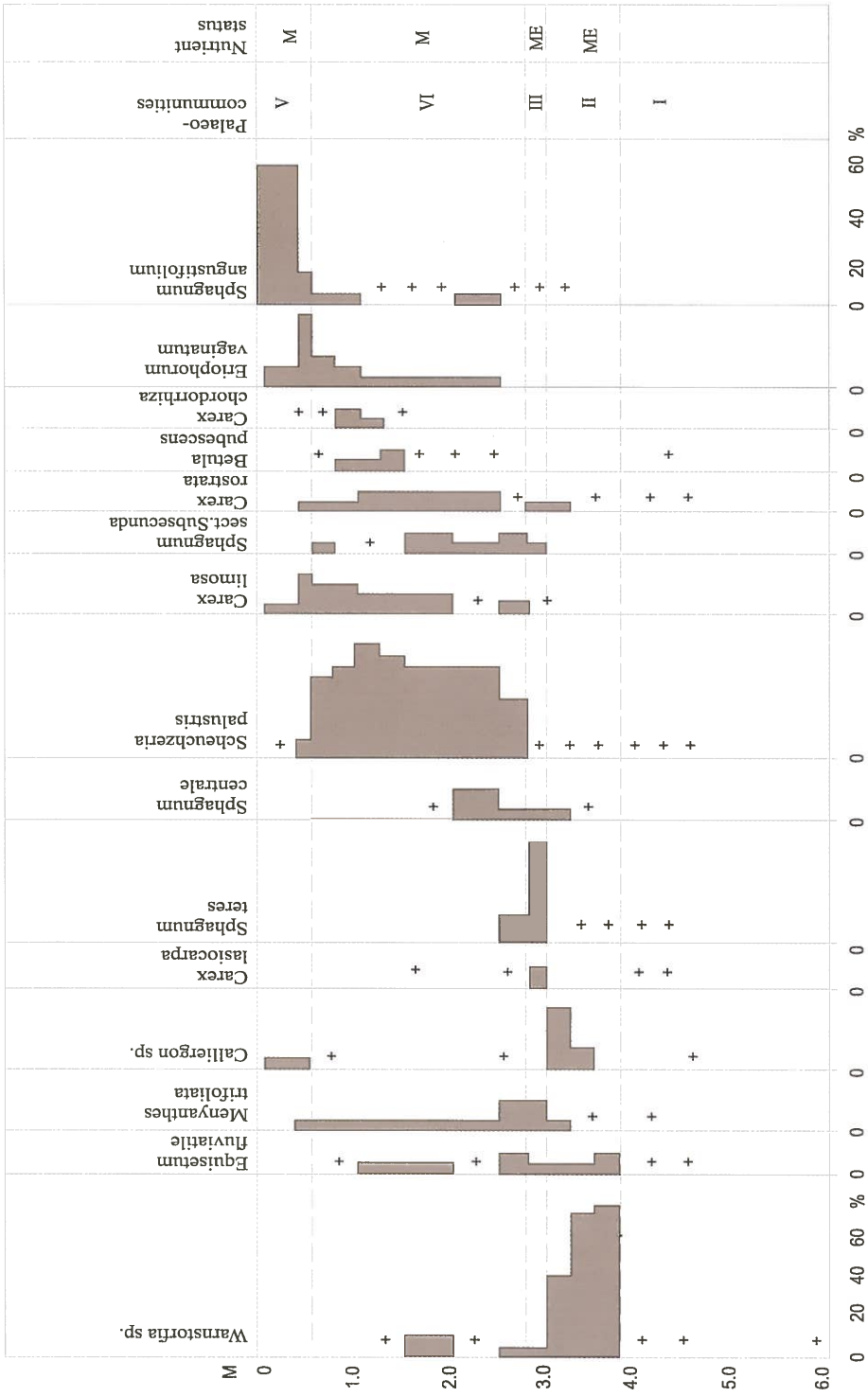

Fig. 11. Macrofossil diagram of Vasensuo (peathole 19). Palaeocommunities: I- lake with macrophytes; II- Warnstorfia sp. + Calliergon sp.; III- Menyanthes trifoliata - Sphagnum teres; IV- Scheuchzeria palustris - Carex spp.; V- Eriophorum vaginatum - Sphagnum angustifolium.

Discussion

The vascular plant flora of mires

The flora of the proposed Kalevala National Park is quite typical of the north taiga sub–zone. The predominance of poor meso–oligotrophic and ombrotrophic mires results in a lack of eutrophic and calcareous plant species. The mire flora of the park is very close to that of the Kostamus Nature Reserve (Kravchenko 1997). Eutrophic spring mires and sloping mires are numerous in Paanajärvi National Park. They contain a rich flora of eutrophic and calciphilous species. Thus the flora of Paanajärvi National Park is more diverse (Kuznetsov 1995 b). The nearest biogeographic province in Finland is Ostrobottnia kajanensis (OK). Some rare plant species which are known to occur in the Kalevala park are quite rare within OK. These are *Carex tenuiflora, C.rhynchophysa, Dactylorhiza cruenta, Frangula alnus,Salix pentandra and S.cinerea* (Hämet-Ahti et al. 1998). Further floristic field studies are urgently needed in both the proposed Kalevala National Park and its surrounding territories.

Flora of Bryophytes

Previously existing data on the mosses of the western part of Karelia was rather fragmentary and mainly related to studies carried out in the Kostamus Nature Reserve and surrounding territories (Yurkovskaya 1974, Elina & Kuznetsov 1977). Corresponding data is also far from complete for the Finnish biogeographical region of Ostrobotania Kajanensis (Wainio 1878; Laaka & Miettinen 1995). A monograph by Brotherus (1923) records 82 moss species (Table 1). However, it appears that at that time no mosses were collected from the area presently under study as the names Venehjärvi and Latvajärvi are not mentioned.

According to Volkova and Maksimov (1993) 196 bryophytes occur in Karelia pomorica occidentalis province. We have recorded 37 new moss species in the investigated area (Boychuk 1998,1999). Three mosses recorded in the region for the first time (*Leptodictyum riparium, Warnstorfia procera, W.trichophylla*) were also recorded by Finnish bryologists in the Kostamus Nature Reserve (Mäkirinta et al. 1997). The current list of bryophytes for KPOC province runs to 236 species (Table 1).

This represents 54 % of the entire moss list of Karelia. Karelia's bryoflora comprises 42 families, 35 of which are represented in the KPOC province. Species from families confined to calcareous conditions have not been found. The *Pottiaceae* family is one from the 10 most dominant bryoflora families in Karelia, with a total of 18 individual moss species. However, in KPOC province only one of these species occurs. The bryoflora of the Kuusamo province (on the Karelian side of the state border with Finland) is, by contrast, much more diverse with 278 moss species from 39 families, including a good number of calcareous mosses (Maksimov 1995, Halonen & Ulvinen 1996).

Classification of mire vegetation

The classification of plant communities of a given region forms the basis for assessing the biodiversity of plant cover from the points of view of rational usage, conservation and protection. At the present time several methods of plant cover classification are used in different countries. These are the physiognomic, ecological–floristic and topological (Aleksandrova 1969, Rybnicek 1985, Moen 1990). The pre-

sent study employs the same ecological–floristic for the classifications of mire communities as is used widely in a number of countries. Classification occurs at four levels, each syntaxon including a group of diagnostic species and the name of the author who described it for the first time. Thorough ecological–floristic classifications of mire communities exist for a number of countries and large regions of Europe (Nordhagen 1943. Dierssen 1982, Rybnicek et al. 1984, Moen 1990). Such a system of classification is also available for Russia (Botch & Smagin 1993, Kuznetsov 1993, 1998). In the establishment of an ecological–floristic classification of Karelian mire vegetation, materials and data from the adjacent regions of Scandinavia (Dierssen 1982) and north–western Russia (Botch & Smagin 1993) have been taken into account. In addition, we studied a large number of associations described by the above–mentioned authors and identified several new associations (Kuznetsov 1998). For instance, the range of Dierssen's associations (1982) includes a very broad spectrum of plant communities which are characterised by both differing ecological habitat conditions and origin (genesis) in such a way as to contradict the principles of ecological–floristic classification. The geographical peculiarities of the mire flora and vegetation of East Fennoscandia favour the identification of new associations. Our classification pays particular attention to the indicative features of moss layers. The necessity for such an approach has been repeatedly pointed out by Rybnicek (1985). Within many associations, a number of sub-associations were described for dominant moss species. Faciations were determined for species predominant in the field layer.

In terms of the composition of plant communities the mire vegetation of the proposed Kalevala National Park is very similar to that of the Kostamus Nature Reserve and Tuulos National Park. However, it differs significantly from the mire vegetation of Paanajärvi National Park (Table 1). The diversity of eutrophic herb (grass), herb (grass) – brown-moss (*Hypnum*) and woody – brown-moss plant communities of the *Caricetalia davallianae* order in Paanajärvi park is caused by the widespread occurrence of calcareous bedrock.

Mire ecosystems, their structure, stratigraphy and genesis

When the ice retreated from north–western Karelia about 9 500 years ago mineral sediments and organic sapropel began to accumulate in numerous post–glacial water bodies (Ekman & Iljin 1991, Elina et al. 1994). As the climate grew warmer most of these small water bodies became shallower and terrestrialisation began. Herb (horsetail, sedge and reed) or green moss (*Calliergon sp., Warnstorfia sp., Scorpidium scorpioides*) communities started the terrestrialisation process in remnant water bodies. In the depressions between ridges and in ravines paludification was started by woody–herb, herb and herb–moss eutrophic and mesoeutrophic communities. Owing to the intense accumulation of peat and horizontal growth of individual mires, huge mire systems were formed. The same genesis, stratigraphy and plant cover structure are characteristic of most of the mire massifs and mire systems occurring along the ridge of Maanselkä. The mires located in the territories surrounding the city of Kostamus (Elina & Kuznetsov 1977, Kolomytsev & Kuznetsov 1997), in the Friendship Park (Heikkilä et al. 1997) and in Paanajärvi National Park (Elina et al. 1994, Kuznetsov et al. 1996) have all been studied in some detail.

Mire system dynamics depend on the combination of hydro–geological and climatic factors. The development naturally tends towards oligotrophisation and then on to the ombrotrophic phase, in which the effect of ground water ceases. The poor bedrock and soils of the proposed Kalevala National Park result in either the curtailed existence or complete lack of the eutrophic stage in the development of mires. Instead, most of them underwent a protracted mesotrophic stage. Many of

the park's mires are presently at this stage of their development. Ombrotrophic mire massifs and facies account for a little under 30 % of the proposed park's area. They have entered the ombrotrophic phase within the last 1 000 to 2 000 years. This is confirmed by the thinness of the layers of ombrotrophic peat at the surface of the mire.

Abundant ground water and atmospheric precipitation throughout the entire period of mire evolution resulted in a predominance of treeless or sparsely wooded grass and grass–moss communities. This is evidenced by the plentiful occurrence of grass, grass–moss and peat of mossy origin as well as by the lesser occurrence of peat containing significant proportions of woody fossils.

Mesotrophic and meso–oligotrophic mires and facies containing welldeveloped moss layers, generally formed by *Sphagnum* mosses, predominate in the territory of the proposed park. Tending towards an oligotrophic state, such mire massifs contain *Sphagnum* communities within the low structural elements of their microtopography. These flarks, carpets, hollows and water tracks are sites of intensive peat accumulation. The mires are not considered to be of the aapa type (Kuznetsov 1982). However, according to Finnish mire researchers the same mires are, indeed, included within the aapa type (Ruuhijärvi 1960, 1988, Eurola et al. 1984). Therefore, the adjacent Finnish area is referred to as an aapa mire region. Typical aapa mires contain well developed ridge–flark patterns. In the deepest flarks and secondary pools at the centre of aapa mires peat accumulation processes ceased some two to three thousand years ago (Kuznetsov 1982). Such mires do not evolve towards an ombrotrophic stage and comprise the climax mire type of the northern boreal zone.

Acknowledgements

The authors gratefully acknowledge the help of colleagues from the Laboratory of Mire Ecosystems (Institute of Biology, Karelian Research Centre, Russian Academy of Science) T. I. Brazovskaya, N. V. Stoikina and G. K. Kornilova, who contributed considerably towards the field work as well as the analysis of collected materials. Sincere thanks also go to A. Yu. Likhachev and O. A. Belkina (Polar-Alpine Botanical Garden Institute, RAS, Kirovsk), and to K. Karttunen (Finnish Environment Institute) for their critical revisions, expertise and assistance in identifying certain Bryidae species. Grateful thanks also to V. V. Zolotov (Main Botanical Garden, RAS, Moscow) for identifying mosses from the *Bryum* genus.

Special thanks go to Pavel Shevelin for the translation of the manuscript into English.

References

Abramova, A. L., Savich–Lubitskaya, L. I. & Smirnova, S. N. 1961: Handbook of mosses in arctic regions of USSR. – Moscow, Leningrad. 714 pp. (In Russian).

Aleksandrova, V. D. 1969: Classification of vegetation. Principles of classification and classification systems of various phytocoenological schools. – Leningrad. 275 pp. (In Russian).

Atlas of Finland. 1988: – Helsinki. 141–143.

Botch, M. S. & Smagin V. A. 1993: Flora and vegetation of mires in the north–west Russia and principles of their protection. – St. Petersburg. 224 pp. (In Russian).

Boychuk, M. A. 1998: Bryoflora of the planned national park "Kalevalsky". – In: Kuznetsov, O. L. & Yudina, V. F. (eds.). Biodiversity, dynamics and conservetion of mire ecosystems of eastern Fennoscandia. Petrozavodsk. 117–132 (In Russian).

Boychuk, M. A. 1999: Comparative analyses of the moss flora in "Kostomukshsky" nature reserve and projected national park "Kalevalsky". – In: Danilov, P. I. (ed.). Biological basis of the study, management and protection in flora, fauna and the soil cover in eastern Fennoscandia. Petrozavodsk. 243 pp.

Braun–Blanquet, J. 1964: Pflanzensociologie. Grunzuge der Vegetatuons Kunde. Wien-New York. 865 pp.

Brotherus, V. F.1923: Die Laubmoose Fennoscandias. – Flora Fennica. N 1. 635.

Cherepanov, S. K. 1995: Vascular plants of Russia and adjacent states. – St. Petersburg. 989 pp. (In Russian).

Classification peat and peat deposits. 1951: – Moscow. 68 pp. (In Russian).

Dierssen, K. 1982: Die wichtigsten Pflanzengeselschaften der Moore NW–Europas. Geneve. 382.

Dombrovskaya, A. V., Koreneva, M. M. & Tyuremnov, S. N. 1959: Atlas of plant macrofossils in peat. – Moscow. 89 p.+ 137 tab. (In Russian).

Ekman, I. & Iljin, V. 1991: Deglacion, the Younger Dryas end moraines; their correlation in the Karelian ASSR and adjacent areas. – In: Eastern Fennoscandian Younger Dryas and Moraines. Excursion guide. Espoo. 73–101.

Elina, G. A. & Kuznetsov, O. L. 1977: Mire types, their usage and protection. – In: Bisce, G. S. & Nesterenko, I. M. (eds.). Biological resources of Kostomuksha region, ways of usage and protection. – Petrozavodsk. 5–23. (In Russian).

Elina, G. A., Kuznetsov, O. L. & Maksimov, A. I. 1984: Structural and functional pattern and dynamics of mire ecosystems in Karelia. – Leningrad. (In Russian).

Elina, G. A., Kuznetsov, O. L., Devytova, E., Stoikina, N. & Maksimov, A. 1994: Modern and holocene vegetation of Paanajärvi National Park (north–western Karelia). – Botanical Journal 79, 4: 13–31 (In Russian).

Eurola, S., Hicks, S. & Kaakinen E. 1984: Key to Finnish mire types. – In: Moore, P. D.(ed.). European mires. – London. 11–117.

Galkina, E. A. 1959: Mire landscapes of Karelia and principles of its classification. – In: Nitzenko, A. A. & Lepin, L. Y. (eds.). Peatlands of Karelia. – Petrozavodsk. 3–48. (In Russian).

Gromtsev, A. N. (ed.). 1998: Inventory of natural complexes and ecological feasibility study of Kalevala National Park. – Petrozavodsk. 56 pp.

Halonen, P. & Ulvinen, T. 1996: The bryoflora of the Paanajärvi National Park. – Oulanka Reports 16: 23–32.

Hedenäs, L. 1993: Field and microscope keys to the Fennoscandian species of the Calliergon–Scorpidium–Drepanocladus complex. BIODETECTOR AB, Marsta. 79 pp.

Hämet-Ahti, L., Suominen, J., Ulvinen, T. & Uotila, P. (eds.) 1998: Retkeilykasvio (Field Flora of Finland). ed. 4 – Finnish Museum of Natural History, Botanical Museum, Helsinki 656 pp. (In Finnish with English Summary.)

Ignatov, M. S. & Afonina, O. M. 1992: Check–list of mosses of the former USSR. – Arctoa, v.1–2. Moscow. 1–86.

Jalas, J. & Suominen, J. 1972: Atlas Florae Europaeae 1. Pteridophyta. 121 pp. Helsinki.

Katz, N. Ya. 1971: Bogs of the world. – Moscow. 295 pp. (In Russian).

Katz, N. Ya., Katz, S. V. & Scobeeva, E. I. 1977: Atlas of plant macrofossils in peat. – Moscow. 376 pp. (In Russian).

Kolomytsev, V. A. & Kuznetsov, O. L. 1997: Mires and paludified forests of the Kostomuksha Nature Reserve. – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.). Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve Friendship. Helsinki. 124: 53–62.

Korotkina, M. Yu. 1939: Botanical analysis of peat. – In: Neustadt, M. I. (ed.). Methods of peat–bog investigation. Part II. Moscow. 5–59. (In Russian).

Kotiranta, H., Uotila, P., Sulkava, S. & Peltonen, S–L. (eds.) 1998: Red Data Book of East Fennoscandia. – Ministry of the Environment, Finnish Environment Institute & Botanical Museum, Finnish Museum of Natural History. Helsinki. 351 pp.

Kravchenko, A. V. 1997: Vascular plants of the Kostomuksha Nature Reserve. – In: Lindholm, T. Heikkilä, R. & Heikkilä, M. (eds.). Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve Friendship. Helsinki 124: 87–98.

Kravchenko, A. V., Gnatyuk, E. P. & Kryshen, A. M. 1998: Vascular plants. – In: Gromtsev, A. N. (ed.). 1998: Inventory of natural complexes and ecological feasibility study of Kalevala National Park. Petrozavodsk. 34–38.

Kuznetsov, O. L. 1982: Structure and dynamic ridge–hollow complexes of aapa mires in north Karelia. – Botan. Jurnal, B.67. N 10. 1394–1400. (In Russian).
Kuznetsov, O. L. 1993: Classification of Sphagnum fuscum, S.magellanicum and S.angustifolium communities in Karelian mires. – In: Boch, M. S. (ed.). Classification of mire vegetation. St. Petersburg. 54–67. (In Russian).
Kuznetsov, O. L. 1995a: Rare and protected vascular plants of the flora of mires in Eastern Fennoscandia. – In: Heikkilä, H. (ed.). Finnish-Karelian symposium on mire conservation and classification. Helsinki. 52–56.
Kuznetsov, O. L 1995b: Rare and protected mire plants of Paanajärvi National Park. – In: Systra, Yu. (ed.). Nature and ecosystems of Paanajärvi National Park. Petrozavodsk. 34–39. (In Russian).
Kuznetsov, O. L. 1998: Biodiversity of plant cover on the mires of Karelia (Russia). – In: Sopo, R. (ed.). The spirit of peatlands. 30 years of the International Peat Society. Jyväskylä. 157–158.
Kuznetsov, O. L., Shevelin, P. & Maksimov, A. et.al. 1996: Mire ecosystems of western Karelia along the Russian–Finnish border. – Oulanka Reports, 16: 139–143.
Laaka, S. & Miettinen A. 1995: Kainuun aarniometsien sammalet. – Inventointiraportti. 1994. Kainuu. 23 pp.
Lopatin, V. D. 1954: 'Gladkoe boloto' (peat deposit and mire facies). – Uchen. Zap. LGU. Ser. Geogr. Nauk, 9. P.95–181. (In Russian).
Maksimov, A. I. 1995: The mosses of the Paanajärvi National Park. – In: Systra, Y. & Shustov, Y. (eds.). Nature and ecosystems Paanajärvi National Park. Petrozavodsk. 84–107 (In Russian).
Masing, V. 1984: Estonian bogs: plant cover, succession and classification. – In: Moore, P. D. (ed.). European mires. London. 119–148.
Mäkirinta, U., Sipola, M. & Nuotio, P. 1997: On the aquatic flora and vegetation of the northern half of Lake Kiitehenjärvi in the Kostomuksha Nature Reserve. – In: Lindholm, T., Heikkilä, R.& Heikkilä, M. (eds.). Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve Friendship. Helsinki. 124: 99–113.
Mela, A. J. & Cajander, A. K. 1906: Suomen kasvio. – Helsinki. 764 pp.
Minkina, C. I.. & Varligin, P. D. 1939: Determination of the degree of peat decomposition. – In: Neustadt, M. I. (ed.). Methods of peat–bog investigation. Part I. Moscow. 115–138. (In Russian).
Moen, A. 1990: The Plant cover of the boreal Uplands of Central Norway. 1. Vegetation Ecology of Solendet Nature Reserve, Haymaking fens and Birch Woodland. – Gunneria, 63. 451 pp.
Norghagen, R. 1943: Sikilsdalen og Norges fjellbeiter. – Bergens Mus.Skr., 22. 607.
Nyholm, El.1954–1969: Illustrated moss flora of Fennoscandia. II. Musci. Lind.; – Stockholm. Fasc. 1–6. 799 pp.
Ramenskaya, M. L. 1983: Analysis of the flora of Murmansk region and Karelia. – Leningrad. 216 p. (in Russian).
Red Data Book of RSFSR. V.2. Plant. 1988: – Moscow. 592 pp. (In Russian).
Red Data Book of Karelia. 1995: – Petrozavodsk. 286 pp. (In Russian).
Ruuhijärvi, R. 1960: Uber die regionale Einteilung der nordfinnischen Moore. – Ann. Bot. Soc. "Vanamo". T.31, N 1. 360 S.
Ruuhijärvi, R. 1988: Mire vegetation. – Atlas of Finland 141–143. App. Helsinki. 2–6.
Rybnicek, K. 1985: A central European approach to the classification of mire vegetation. – Aquilo. Ser. Bot. T.21. 19–31.
Rybnicek, K, Balatova – Tulackova, E. & Neuhausl, R. 1984: Prehled rostlinnych spolecenstev raselinist a mocradnich luk Ceskoslovenska. – Stud. CSAV. T.8. Praha. 123 pp.
Savich – Lubitskaya, L. I., Smirnova, S. N. 1968: Handbook of Sphagnum mosses in USSR. – Leningrad. 112 pp. (In Russian).
Volkov, A. D., Gromtsev, A. N. & Yerukov, G. V. et al. 1995: Ecosystems of western north–taiga landscapes. – Petrozavodsk. 194 pp. (In Russian).
Volkova, L. A. & Maksimov, A. I. 1993: List of mosses in Karelia. – In: Elina, G. A. & Volkov, A. D. (eds.). Vegetation world of Karelia and the problem of its protection. – Petrozavodsk. 57–91. (In Russian).
Wainio, E. 1878: Kasvistonsuhteista Pohjois–Suomen ja Venäjän–Karjalan rajaseuduilla. – Helsinki. 160 pp.

Yurkovskaya, T. K. 1974: Structure of plant cover in north–west Karelia on the example of Kontokki lake surrounding. – In: Pjavchenko, N. I. (ed.). Ways of investigation and usage of mires in the north–west of the European part of USSR. Leningrad. 32–34. (In Russian).

Yurkovskaya, T. K. 1980: Mires. – In: Gribova, S. A. et al. (eds.). Vegetation of European part in USSR. Leningrad. 300–345. (In Russian).

Yurkovskaya, T. K. 1993: Plant cover of Karelia. – In: Elina, G. A. & Volkov, A. D. (eds.). Vegetation world of Karelia and the problem of its protection. Petrozavodsk. 8–36. (In Russian).

Insect fauna of the Paanajärvi National Park and proposed Kalevala National Park with particular emphasis on saproxylic Coleoptera, Diptera and Hymenoptera

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Abstract

Entomological studies were conducted during the period 1996–1998 in the primeval forests of Paanajärvi National Park and its surroundings, and the proposed Kalevala National Park in north–western Russian Karelia. The studies focused on saproxylic Coleoptera, Diptera and Hymenoptera. In total, 161 species of Coleoptera, 159 species of Diptera, 42 species of Hymenoptera and 17 species of other orders have been found in Paanajärvi National Park. In the proposed Kalevala National Park we recorded 179 species of Coleoptera, 248 species of Diptera, 51 species of Hymenoptera and 23 species of other orders. Most Diptera and Hymenoptera species were recorded for the first time from the areas surveyed. Of the Coleoptera recorded 55 species had not been formerly found in the Paanajärvi area. Of these *Trypophloeus bispinulus* Egg. (Scolytidae) constitutes a completely new species for Karelia while *Hylobius sibiricus* Egorov sp.n. (*albosparsus* auct. nec Boh. 1845) (Curculionidae) was recorded for the first time in the whole of Fennoscandia. An annotated list of rare, threatened and other remarkable species is presented. Twenty–five species are proposed as potential indicators of old growth forests in north–western Karelia.

The state of health of stands together with the occurrence of potential insect pests were studied at 26 sampling plots in Kalevala and 11 sampling plots in Paanajärvi. These plots together incorporated a total of 1979 pine and 1156 spruce trees. Results indicate a comparatively good state of health of forest stands in the areas surveyed. In pine forests on mineral soils the proportion of dead trees at the sampling sites varied from 5,4 to 19,1 % in Paanajärvi and from 1,7 to 31,7 % in Kalevala. In certain stands which had been subjected to resin extraction a high mortality of pines (31,7 %) was observed on only one of the six sites surveyed. In spruce forests the proportion of dead trees was between 3,4 and 15,2 % on the sampling plots at Paanajärvi and between 3,6 and 14,7 % at Kalevala. Neither signs of outbreaks of

insects nor symptoms of forest decline due to insect pest were observed in either area. Proposals for the incorporation of particular areas of land into the existing and planned protected territories are included.

Key words: entomofauna, threatened insect species, insect pests, primeval forests, Paanajärvi National Park, Kalevala National Park, Russian Karelia.

Introduction

In order to minimise the detrimental effects of forestry activities on the natural diversity of forest ecosystems it is necessary to understand the various mechanisms which sustain this diversity. Unfortunately, data describing primeval forest ecosystems in Northern Europe prior to the advent of anthropogenic influences are lacking. However, it is possible to obtain such data by studying forests that have developed naturally and without human interference. The processes of succession in virgin forests are driven by natural disturbances such as fire, flooding, storm damage, pathogenic fungi and outbreaks of insects. Extensive areas of forest preserved in the north–west of the Republic of Karelia have never been subjected to significant clear felling and thus provide an important opportunity for the study of the natural composition and structure of boreal forest ecosystems at different successional stages. Indeed, they could serve as areas of reference for the whole of Fennoscandia, by which the processes of natural forest succession could be reconstructed.

The study chose insect communities associated with wood–decomposition systems (saproxylic species) as a target group for evaluation of the conservation value of primeval forest areas in Russian Karelia. The reason for this choice was twofold. Firstly, saproxylics are a species–rich group occupying a heterogeneous range of habitats and, secondly, they are highly sensitive to human–induced changes to the forest structure.

Saproxylic insects were defined by Speight (1989) as "species that are dependent, during some part of their life cycle, upon the dead or dying wood of moribund or dead trees (standing or fallen), or upon wood–inhabiting fungi, or upon the presence of other saproxylics". They are proven to be one of the best indicator groups for the conservational value of forest habitats. Experience of the long–term intensive exploitation of the natural forests of Western Europe indicates the high vulnerability of saproxylic insect species to anthropogenic changes in forests as a consequence of the loss or deterioration of their habitats (Väisänen et al. 1993). Many of these species dwell in old growth coniferous forests and the availability of sufficient quantities of coarse, woody debris at various stages of decay seems to be a crucial factor for their survival (Siitonen et al. 1995). It appears that many species are capable of surviving only in unmanaged old growth forests which contain plenty of dead wood.

At present, Coleoptera is the best known group of saproxylic invertebrates. In recent years intensive studies on the diversity and abundance of saproxylic beetles in connection with ecological factors have been conducted in the adjacent forest areas of Finland and Russian Karelia (Kaila et al. 1994, Siitonen & Martikainen 1994, Siitonen et al. 1995, 1996, Martikainen et al. 1996, Yakovlev 1996, Yakovlev et al. 1995, 1998). Besides Coleoptera there are several other insect groups which could serve as potential indicators. One of these is Diptera, especially those species belonging to the families of Bolitophilidae and Keroplatidae as well as Mycetophilidae from the subfamily of Sciaroidea. These include many species which are perforce dependent on fungal fruiting bodies or mycelia growing in dead wood. Some Hymenoptera species groups such as Ichneumonidae, which are parasites of threatened species of saproxylic beetles, are even more vulnerable than their hosts. The

species composition and ecology of these species is still little known. However, the first attempts to use them as potential indicators of the conservational value of forest habitats (Økland 1994) have produced promising results.

Primeval forests are also interesting habitats from the point of view of forest protection. It has been suggested that protected areas of natural forests could act as sources of insect pests. Karelia does not lie in a region with a high probability of pestilence. However, in view of the targeted protection of extensive areas of old growth forests, the monitoring of the occurrence of potential insect pests may be of interest.

Our present knowledge of the forest insect fauna of the northern part of Russian Karelia is still very poor. During the last fifty years studies on the species composition and ecology of forest insects in Karelia were carried out mainly in young stands. Data concerning insects inhabiting old growth forests remains in short supply and is almost exclusively based on materials collected from the southern part of the republic (Shiperovich 1949, Yakovlev et al. 1986, Mozolevskaja et al. 1991, Kaila et al. 1994, Yakovlev 1996, Martikainen et al. 1996). The only exceptions to this general rule throughout the extensive territories to the north of Medvezhegorsk come from two locations: firstly, Paanajärvi National Park, where studies were undertaken by Finnish entomologists during the first half of the century (see Viramo 1998) and, secondly, the Kostamus Nature Reserve, where beetle fauna have been recently investigated (Rutanen & Kashevarov 1997).

This study focuses on insect fauna and pays particular attention to certain groups of saproxylic species in one of the last remaining areas of old growth forest of significant size in Fennoscandia. The aims of the study were:

(1) To assess the state of health of the forests and to study the occurrence of potential insect pests in stands of unmanaged old growth forest.
(2) To explore the species composition of saproxylic insect communities, paying special attention to species which are strictly confined to primeval forest habitats.
(3) To gather faunistic data on other, non–saproxylic insects.
(4) To collect data on the distribution of rare, vulnerable and potential indicator species.
(5) To assess the conservational value of the existing and proposed protected areas in the Paanajärvi and Kalevala regions on the basis of data concerning insect fauna.

Study areas

During the summer of 1998 two expeditions were undertaken to Paanajärvi National Park and to the territory of the proposed Kalevala National Park. Information from previous expeditions to the Paanajärvi area (Nuorunen Fell 10.–21.07.1990, the River Oulanka between Paanajärvi and the Kivakkakoski waterfall 18.–28.08.1993) and to Kalevala (10.–24.07.1996, 16.–24.06 and 1.–12.08.1997) is also included in this report.

National Park Paanajärvi and its surroundings

General features

Steep, east-west oriented hills and depressions covered with almost untouched coniferous forest characterise the landscape of this area. The natural forests of the Paanajärvi area were the subject of one of the classic descriptions of forest types of boreal low–mountain taiga (Yakovlev & Voronova 1959). The characteristics of natural forests of the Paanajärvi area are also set out in various later publications (Volkov et al 1995, Gromtsev et al. 1995, Ovaskainen 1998). These forests have developed naturally with minimal human interference. Forest fires constitute the main source of disturbance in dry, pine–dominated forests growing on mineral soils, while small–scale gap regeneration prevails in wetter areas. Both the pine and spruce forests of Paanajärvi are of uneven age and contain numerous old trees aged 200 years and more. The amount of dead wood, including both standing and fallen trees is high, and is formed mainly by coniferous trees.

Spruce–dominated forests occupy 68 % of all forests within the park. Eleven different forest types of spruce are represented. The majority of spruce–dominated stands grow together with an admixture of birch and aspen on *Myrtillus* type sites featuring hilly slopes and depressions (Fig. 1).

Fig. 1. Spruce-dominated primeval forest in Paanajärvi National Park.

The pine forests of the park are mostly of pyrogenic origin. They cover approximately 27 % of the total area and are mainly confined to the water–glacial delta of the River Olanga. Pine forests of the *Cladonia* type prevail in the area surveyed. *Cladonia* type pine forests are of no essential economic importance owing to their slow rate of growth and the low quality of the timber produced. However, their ecological role is of indisputable significance. Stands of pure pine with individual spruces and birches occur on the slopes of hills and eskers. Such stands are of low density (0,3 – 0,4) containing an average stock of only 40 – 60 cubic metres per hectare. The sparse bush layer consists of willow, juniper and rowan. At the grass/dwarf shrub layer *Calluna vulgaris, Vaccinium vitis-idaea* and *Arctostaphylos uva-ursi* often dominate. Lichens of the genus *Cladonia* prevail in the soil layer. Northern variant pine forest of the *Empetrum – Cladonia* type is quite commonly observed (Fig. 2).

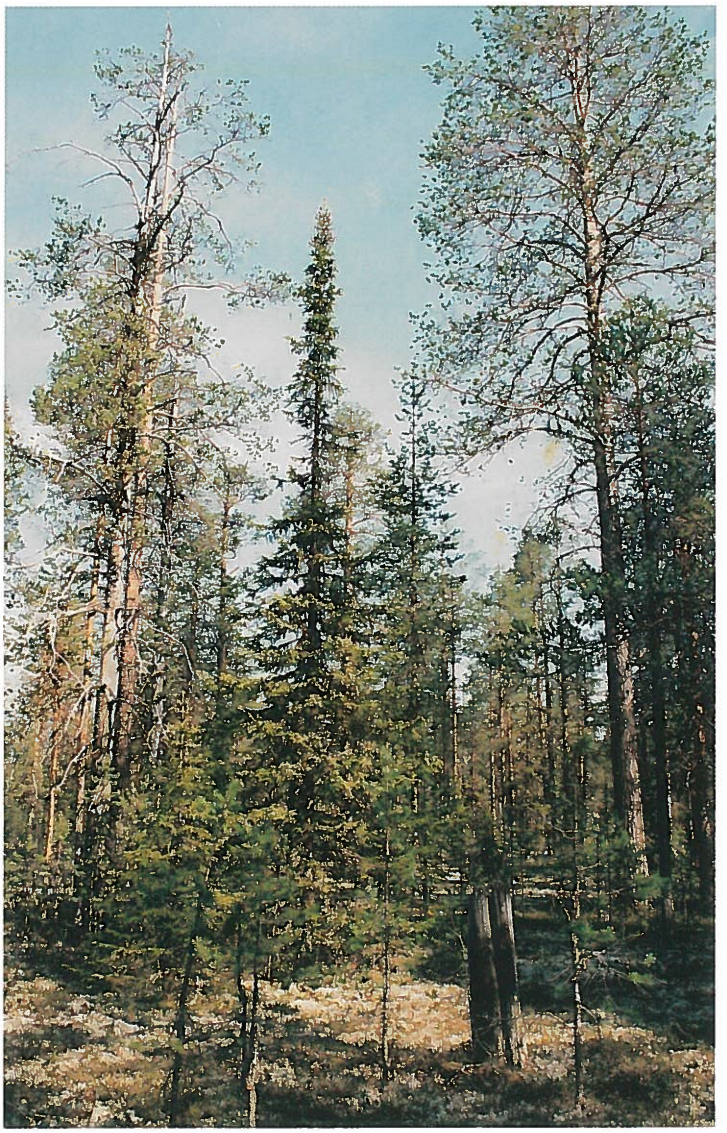


Fig. 2. Typical pine forest in Paanajärvi National Park.

Study sites

In the Paanajärvi area we investigated a total of 11 study sites (Fig. 3). Nine of these were located within the boundaries of Paanajärvi National Park while the remaining two, at Tsipringa (site 8) and Päänuorunen Fell (site 9), were situated in unprotected areas outside the park territory.

The present area of Paanajärvi National Park can be roughly divided into two parts, each belonging to a different biological province. The western half is situated at the easternmost extreme of the *Regio Kuusamoensis*, a former Finnish territory (Sites 1, 2 and 11), while the eastern half occupies the westernmost fringe of the *Karelia keretina* (Sites 3–10). The western half of the research area is characterised by northern boreal forests dominated by spruce whereas the eastern section is mostly taken up by one of the largest glaciofluvial deltas in Karelia and is covered by pine-dominated forests. The spruce forests of the eastern part were studied along the valleys of the rivers Oulanka, Astervajoki and Leppäjoki, and in moist depressions.

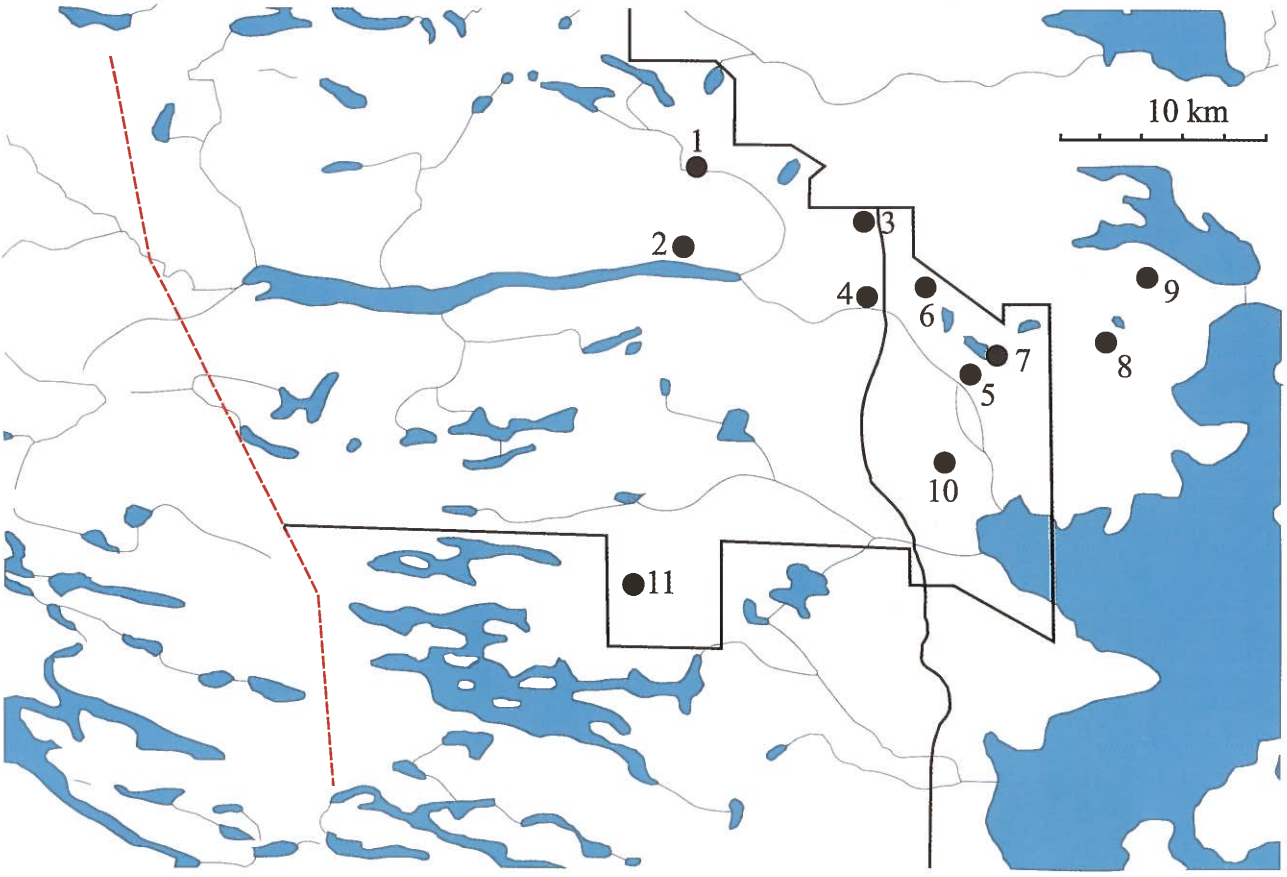


Fig. 3. Location of sample plots in Paanajärvi National park and adjacent territories. Eastern and Southern borders of the present area of national park and the main road from Pääjärvi to the end near the Neris lakes are indicated. Site numbers are as follows: 1 - Mutkalampi, 2 - Alatalo, 3 - Astervajoki, 4 - Oulankajoki, 5 - Vartiolampi, 6 - Olenii Bor, 7 - Jungojärvi, 8 - Tsipringa, 9 - Päänuorunen, 10 - Kivakka, 11 - Nuorunen.

The structure and other characteristics of the forests in the eastern part of Paanajärvi have still not been studied in detail. According to a recent study (Dyakonov 1998) they are characterised by "low density, low productivity and almost the complete absence of human interference". However, clear signs of previous selective cuttings performed several decades ago were found at almost all sampling sites situated close to the shores of Lake Paanajärvi, the River Oulanka and along the road from Paanajärvi to Lake Tsipringa. Furthermore, signs of fire were in evidence in all the pine–dominated forests.

The characteristics of study sites and numbering of sampling plots within each site are given in Table 1.

Table 1. Study sites and sampling plots in Paanajärvi National Park

Study site	Sampling plot	Study site	Compartment	Forest type*	Tree species composition	Average age	Signs of logging
1	1a	Mutkalampi	47	MT	8S2B+A	180	-
1	1b	Mutkalampi	47	MT	8S2B+A	180	-
2	2	Alatalo	60	GMT	7S2B1A	140	-
3	3	Astervajoki	63	MT	9S1B+A	180	+
4	-	Oulankajoki	87,93	MT	6S2P2B+A	140	+
5	-	Vartiolampi	94	HRT	6B3S1A+Al	60	+
5	-	Vartiolampi	94	Meadow	-	-	-
6	6a	Olenii Bor	90	CT	9PIS	220	+
6	6b	Olenii Bor	90	CT	9PIS	220	+
6	6c	Olenii Bor	65	Mire	10P	200	-
6	6d	Olenii Bor	65	Mire	10S1B	200	-
7	7a	Jungojärvi	94	CT	9PIS	200	+
7	7b	Jungojärvi	94	MT	9S1B+A	160	+
8	8a	Tsipringa	-	CT	9PIS	200	-
8	-	Tsipringa	-	CT	10P	180	+
8	-	Tsipringa	-	MT	8S2B+A	160	+
9	-	Päänuorunen	-	CT	10P	180	+
9	-	Päänuorunen	-	GMT	5S2P2B1A	140	+
10	-	Kivakka	109	EMT	8S2B+A	180	-
11	-	Nuorunen	128	MT	8S2B+A	180	-

* forest types: MT – *Myrtillus* type; GMT – *Geranium-Myrtillus* type; CT – *Cladonia* type; Mire – forest covered mire; EMT - *Empetrum-Myrtillus* type.

The proposed Kalevala National Park and its surroundings

General features

The territory of the proposed Kalevala National Park forms one of the largest continuous areas of primeval old growth boreal forest remaining in Fennoscandia. The greater part of its area is covered by pine–dominated forests at different stages of pyrogenic succession (Fig. 4). The average age of pine trees on mineral soil is 120–160 years. About half of the original generation of pines has been selectively cut. This had no great effect on the recent structure of the stands. However it led to an increase in the proportion of spruce in particular places (Gromtsev 1999).

There is little scientific data available for the area. Recent inventories on the history of human settlement, landscape, soil and vegetation, as well as studies on the distribution of indicator species have been conducted and published by scientists from the Karelian Research Centre (Gromtsev 1998, Krutov & Gromtsev 1998) and the Finnish Nature League (Ovaskainen 1998).

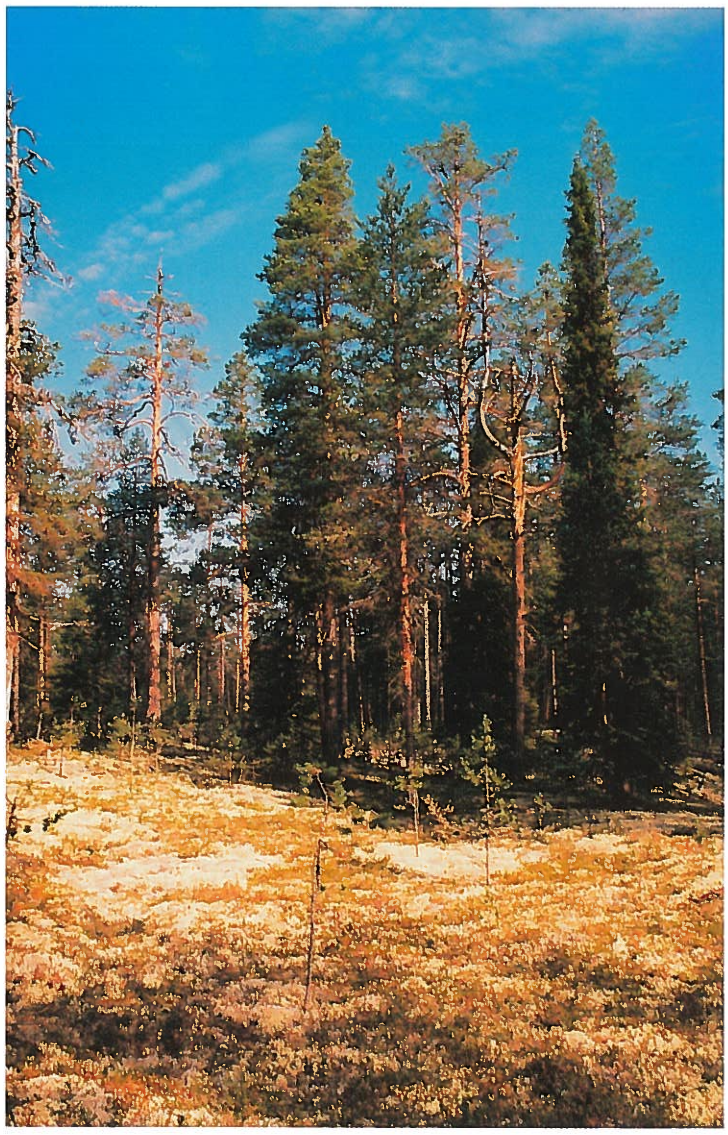


Fig. 4. Typical pine forest in the proposed Kalevala National Park.

Study sites

The territory of the Kalevala National Park, as drawn up by the Karelian Government in August 1997, is indicated on the map (Fig. 5). Studies were conducted within the areas of three forestry districts: Latvajärvi compartments 4, 5, 7, 9), Vuokkiniemi (compartments 4, 22, 54, 108–112, 136, 140–142, 168, 173, 177–181,) and Vuonninen (compartments 157–159, 178–179). The characteristics of study sites and numbering of sampling plots within each site are given in Table 2.

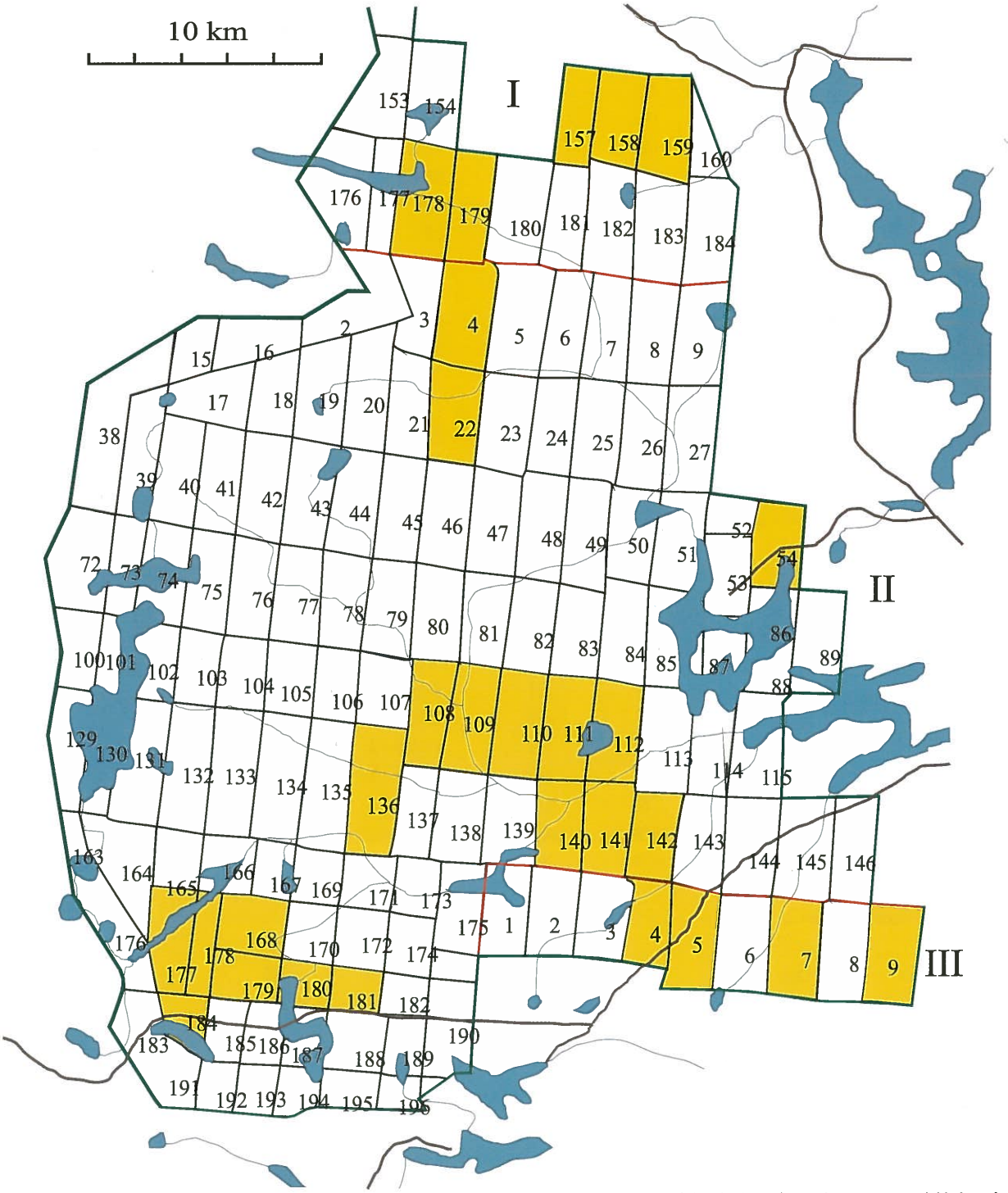


Fig. 5. Location of squares where the entomological researches were conducted (shaded out) in the proposed Kalevala National Park. Borders of the proposed territory of the national park are given as it was reserved by the Act of Karelian Goverment in August, 1997. Forestry districts indicated with roman numbers: I - Vuonninen, II - Vuokkiniemi, III - Latvajärvi.

Table 2. Study sites and sampling plots in the proposed Kalevala National Park

Site	Sampling plot	Site name	Compartment	Forest type*	Tree species composition	Average age	Signs of logging	Signs of resin extraction
Vuokkiniemi Foresty District								
1	1	Venehjärvi	54	MT	8P1S1B	140	+	-
2	2a	Ahkiva River	109	EVT	8P1S1B	120	+	-
2	2b	Ahkiva River	112	MT	6S2P1B1A	180	+	-
3	3a	Kaba River	173	EVT	8P1S1B	140	+	-
3	3b	Kaba River	173	EVT	8P1S1B	140	+	-
3	3c	Kaba River	136	EVT	8P1S1B	140	+	-
4	4a	Vuokinjoki	140	MT	8P1S1B	140	+	-
4	4b	Vuokinjoki	140	EVT	8P1S1B	140	+	+
4	4c	Vuokinjoki	142	EVT	10P	260	+	+
4	4d	Vuokinjoki	142	MT	10P	260	+	+
5	5a	Lake Hoikkajärvi	177	MT	7P2S1B	160	+	-
5	5b	Lake Hoikkajärvi	177	MT	7S1P2B+A	120	+	-
5	5c	Lake Hoikkajärvi	178	Mire	9S1B	180	-	-
6	-	Lake Latvajärvi	181	MT	8P1S1B	160	+	-
6	-	Lake Latvajärvi	181	MT	7S1P 2B	180	-	-
10	10a	Notchnoi Brook	4	MT	7S2P1B+A	140	+	-
10	10b	Notchnoi Brook	4	MT	8P1S1B	140	+	-
11	11	Lake Kurty	23	Mire	10P	200	-	-
13	13a	Lake Vazha	178	MT	7S1P2B+A	160	+	-
13	13b	Lake Vazha	177	MT	7S1P2B+A	140	+	-
Vuonninen Foresty District								
7	7a	Lake Haukilampi	158	EVT	8P1S1B+A	160	+	+
7	7b	Lake Haukilampi	159	EVT	8P1S1B+A	140	+	+
7	7c	Lake Haukilampi	159	EVT	8P1S1B+A	160	+	+
8	-	Kurzhma River	157	EVT	8P1S1B+A	120	+	-
8	-	Kurzhma River	157	EVT	8P1S1B+A	120	+	-
8	-	Kurzhma River	157	MT	7S1P2B+A	120	+	-
9	9a	Lake Levi	178	EVT	8P1S1B	160	+	-
9	9b	Lake Levi	178	Mire	8S2B	180	-	-
9	9c	Lake Levi	178	MT	8P1S1B	140	+	-
Latvajärvi Foresty District								
12	12a	Lake Kormilo	5	MT	6P3S1B+A	140	+	-
12	12b	Lake Kormilo	7	MT	7S2B1A	180	-	-

* forest types: MT – *Myrtillus* type; EVT – *Empetrum-Vaccinium* type; Mire – forest covered mire.

Materials and methods

Measurement of the state of health of forests and the occurrence of insect pests

The monitoring of the health state of forests began in the proposed Kalevala National Park in 1997 and in Paanajärvi National Park in 1998. It incorporated the following steps,

- a preliminary survey of the forests within the national parks and their border zones;
- selection of the most typical forest sites for establishing a network of permanent sampling plots at each site;
- the establishment of temporary sampling plots within the various forest habitats found in the areas investigated.

In order to determine the health state of the forests and to conduct a detailed analysis of insect pests we tried to select sampling plots within minimally transformed, unevenly–aged coniferous forests types, including both pine and spruce and containing a completely or partially intact first generation of pine aged 200 years or over. Several sampling plots were chosen close to roads in order to determine the dynamics of stands subject to varying degrees of disturbance.

Sampling plots were established at the centre of stands at each particular study site. A total of 37 sampling plots situated in a variety of forest types of average age 140–260 years were established. Of these 23 were in pine–dominated stands of *Myrtillus*, *Vaccinium*, *Empetrum–Vaccinium*, *Sphagnum* and *Cladonia* types, and 14 in *Myrtillus* type spruce forests and herb–rich mires. In Paanajärvi there were 11 (Table 3) and at Kalevala 26 sampling plots (Table 4). A total of 1,414 pine and 695 spruce were included in the detailed entomological analysis carried out at Kalevala, and 565 pine and 461 spruce in Paanajärvi.

A thorough health inspection of the selected stands was performed using published techniques established in Russia (Mozolevskaya et al. 1984, 1990). At each sampling plot we studied the health condition of at least one hundred trees along a one metre wide transect. For each individual tree we recorded the species, diameter (cm) and health state category to which it belonged. We used an eight–point system of classification as follows: (1) healthy, (2) slightly weakened, (3) profoundly weakened, (4) dying, (5) recently died, (6) snags, (7) windthrow, (8) windbreak. In cases of trees exhibiting signs of insect colonisation we recorded the insect species (or genus) according to the appearance of imagos or the presence of larvae and larval galleries found under the bark or in wood. Because of the absence from most of the sampling plots of trees which had died recently we were in many instances able to use only larvae galleries for identification purposes. In many cases it was only possible to determine the genus or family of the insect concerned. Only the basal sections of standing trees were examined. This led to unrepresentatively low numbers recorded for species which usually colonise the crowns and upper branches of trees.

Collecting methods

Hand picking

The most commonly employed method of collection was the hand picking of insects found under bark, in the wood of dead trees or on polypore fruiting bodies. In particular, hand picking was employed in the detailed examination of dead and weakened trees both within each sampling plot and outside the boundaries of the sampling plots. Sweep–net samples were taken wherever possible.

Insect trapping

For Coleoptera we used two different trapping methods, the first employing standard window traps and the second trunk window traps. The standard window trap is a flight interception trap based on the principle that flying individual insects hit a transparent window and fall into a collecting funnel (Økland 1995). In our study the window trap consisted of two crossed transparent acrylic sheets (70 cm x 40 cm) mounted above a plastic funnel leading into a one litre container. A concentrated solution of NaCl in water containing a small amount of detergent was placed into the container in order to collect and preserve the insects.

The trunk window trap is specially designed for insects associated with shelf fungi (Kaila 1993). It shares the same principle as the standard window trap but in this case a window measuring 20 cm x 25 cm was placed in a vertical slit cut through the sporocarp of the polyporous fungi *Fomes fomentarius* or *Fomitopsis pinicola*.

In the Kalevala park 60 standard window traps and 30 trunk window traps were in operation from June 16th until October 2nd at three plots in compartments 4 and 9 of the Latvajärvi Forestry District and compartment 142 of the Vuokkiniemi Forestry District. Twenty standard and ten trunk window traps were set on each plot and emptied twice (on August 2nd and October 2nd). The standard window traps were placed close to dead trees or logs in order to attract saproxylic beetles. The average distance between traps was 50 metres. Trunk window traps were set on suitable trees bearing polypore fruiting bodies.

For Diptera and Hymenoptera we used portable Malaise traps described in detail by Townes (1972). Two Malaise traps were operational during the period July 10th – 20th 1996 in compartments 168 and 180 of the Vuokkiniemi Forestry District in the proposed Kalevala National Park and between 20th and 30th June 1998 at the Olenii Bor site in Paanajärvi National Park.

Insect material

Collected materials were first sorted and then pinned or preserved in 70 % alcohol pending further processing in laboratory. The majority of the material is stored at the Forest Research Institute of the Karelian Research Centre, Russian Academy of Sciences (Petrozavodsk, Russia). Several other specimens are housed in the Moscow State University Zoological Museum, Moscow. Taxonomic coverage of the three insect orders forming the main subject matter of the study was as follows.

Coleoptera

Individuals belonging to the saproxylic families of Coleoptera were identified at a species level with the exception of Staphylinidae and almost all Cryptophagidae. In addition, the identification in Kalevala park of the genus *Epuraea* (Nitidulidae) and most Latridiidae remains incomplete. Several species–rich families belonging to other ecological groups such as Carabidae and other soil and water beetles were

not included in the present study. Individuals caught in the traps were counted. Only a qualitative record was kept of those collected by hand. The nomenclature of beetles follows Silfverberg (1992).

Diptera

We tried to identify exhaustively at least all the most abundant saproxylic groups of Diptera. This was possible in the case of the following families: Tipulidae, Limoniidae (excepting some species of *Dicranomyia*), Bolitophilidae, Keroplatidae, Mycetophilidae, Empididae and Heleomyzidae. Practically no identification problems were met with in cases of small groups and comparatively large families, represented in our material by a few species. However, several families were treated only in part (Scatophagidae, Syrphidae, Dolichopodidae, Ephydridae, Muscidae) or not at all (Pipunculidae). Moreover, even among the completely treated groups many questionable identifications were made which require further verification. Such species are indicated in the appendices by a question mark.

Hymenoptera

Representatives of this order were identified with the exception of sawflies (family Tenthredinidae), bracon–flies (Braconidae), bees (except Apidae) and several groups of Microhymenoptera, such as Chalcidoidea, Proctotrupoidea, Cynipoidea, etc. Identification of certain Ichneumonidae was only possible to the level of genus owing to an unsettled taxonomy and lack of specialist literature.

Minor groups from other orders such as Odonata, Blattoptera, Orthoptera, Raphidioptera, Lepidoptera (Rhopalocera), and Heteroptera (Aradidae) were also identified.

Results

Forest health

Spruce stands

The Paanajärvi area is characterised by two widely distributed types of *Myrtillus* spruce forests. The first consists of stands growing on rocky plateaux while the second occupies the slopes and bottoms of hills and river valleys. As a rule, spruce forests in rocky localities are of low productivity. However, in small valleys and depressions with thickened soil layers and moderate levels of moisture certain individuals may achieve significant heights and diameters of over 60 cm.

Of the six sampling plots located in spruce forests three (plots 2, 3, and 7b) were sited in plains, two (plots 1a and 1b) on a rocky plateau and one (plot 6d) in a spruce–covered mire. There are no signs of previous felling on any of the plots. The proportion of dead trees recorded on each plot varies between 3,4 % and 15,2 %. On the rocky plateau the proportion is relatively high (Table 3). Dead trees most commonly occur in the main canopy level and have average diameters of between 20 cm and 30 cm. (Fig. 6 A, B). However, the fact that most of these consist of old snags and windthrow while trees which have died recently are almost completely absent indicates that pathological processes are not presently operating. The weakened trees belong mostly to the second category (slightly weakened), making up between 25 % and 50 % of the total population.

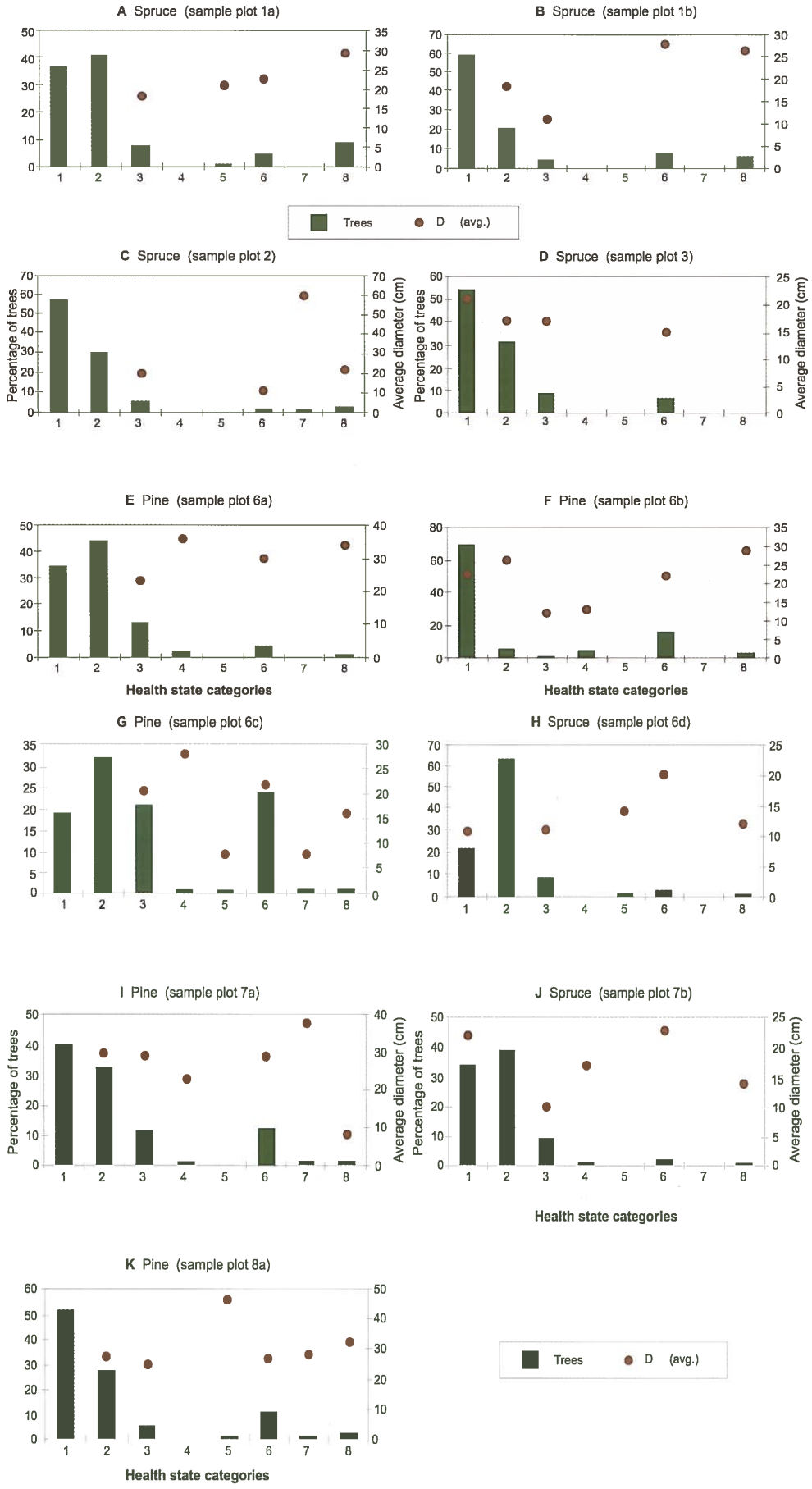


Fig. 6. Distribution of health state categories of trees and their mean diameter in different categories in Paanajärvi National Park.

Table 3. General characteristics, distribution of trees according to state of health and ratio of dead trees at the sampling plots in Paanajärvi National Park

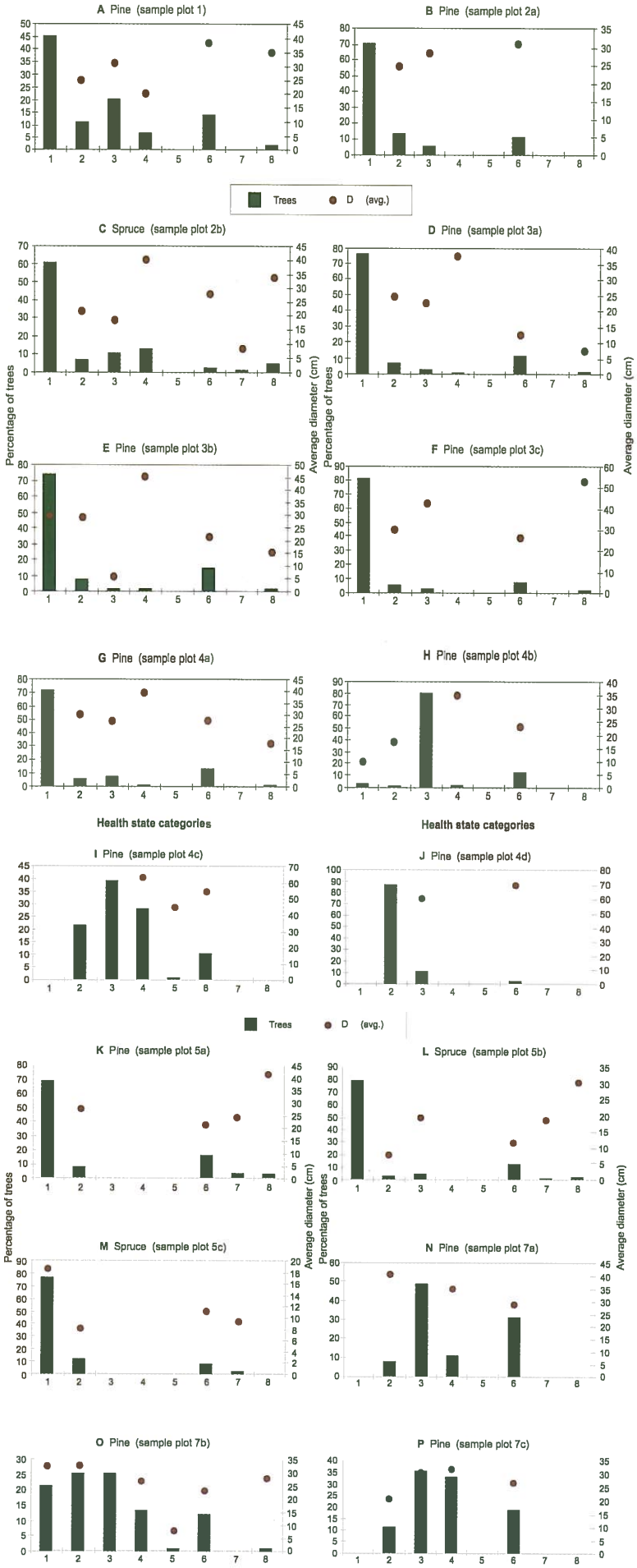
Sampling plot	Main tree species	Average diameter (cm)	Number of trees by category*									Ratio of dead trees (%)
			Total	1	2	3	4	5	6	7	8	
1a	Spruce	21,4	90	33	37	7	0	1	4	0	8	14,4
1b	Spruce	21,3	105	62	22	5	0	0	9	0	7	15,2
2	Spruce	20,9	94	54	29	5	0	0	2	1	3	6,4
3	Spruce	17,5	96	52	30	8	0	0	6	0	0	6,3
6a	Pine	26,3	92	32	41	12	2	0	4	0	1	5,4
6b	Pine	20,6	89	62	5	1	4	0	14	0	3	19,1
6c	Pine	18	100	19	32	21	1	1	24	1	1	27
6d	Spruce	13,1	94	21	60	8	0	1	3	0	1	5,3
7a	Pine	25,1	89	36	29	10	1	0	11	1	1	14,6
7b	Spruce	17	86	34	39	9	1	0	2	0	1	3,4
8a	Pine	29,3	91	47	25	5	0	1	10	1	2	15,3

* Category of tree condition: 1– healthy , 2 – weakened, 3 – profoundly weakened, 4 – dying.
5 – recently died, 6 – snags, 7 – windthrow, 8 – windbreak.

In the more favourable conditions found on slopes and in river valleys the proportion of dead trees is much lower. In these locations dead trees are, as a rule, confined to groups of lower diameter, i.e. 10 cm – 20 cm while trees which have recently died are again absent (Fig. 6 C, D). The proportion of slightly weakened trees is very similar at 31 % – 45 %.

The spruce–covered mire (Fig. 6 H) is characterised by a generally thinner coverage of trees. The percentage of dead trees is similar to that in spruce stands growing on mineral soils while that of weakened trees is much higher at 72 %.

In Kalevala National Park *Myrtillus* type spruce stands grow on more fertile soils. In contrast to the Paanajärvi area, eight sampling plots were selected at sites where previous selective felling activities were in evidence. The health state characteristics observed were, nevertheless, very similar to those found in Paanajärvi (Table 4). The proportion of dead trees varies from 3,3 % to 14,7 %. On most of the sampling plots (Fig. 7 C, L , R, T, Z) the dead trees belong to the main canopy level. On three plots (Fig. 7 M, X, Y) mortality is higher among trees of lower diameter. Profoundly weakened, dying and recently deceased trees are present in small numbers in only four plots (Fig. 7 C, L, T, Z). The proportion of weakened trees is lower than in Paanajärvi with the exception of those on plots situated in areas of high moisture. (Fig. 7 C,T).


A Pine (sample plot 1)
B Pine (sample plot 2a)
Trees
D (avg.)
C Spruce (sample plot 2b)
D Pine (sample plot 3a)
E Pine (sample plot 3b)
F Pine (sample plot 3c)
Percentage of trees
Average diameter (cm)
G Pine (sample plot 4a)
H Pine (sample plot 4b)
Health state categories
I Pine (sample plot 4c)
J Pine (sample plot 4d)
K Pine (sample plot 5a)
L Spruce (sample plot 5b)
M Spruce (sample plot 5c)
N Pine (sample plot 7a)
O Pine (sample plot 7b)
P Pine (sample plot 7c)

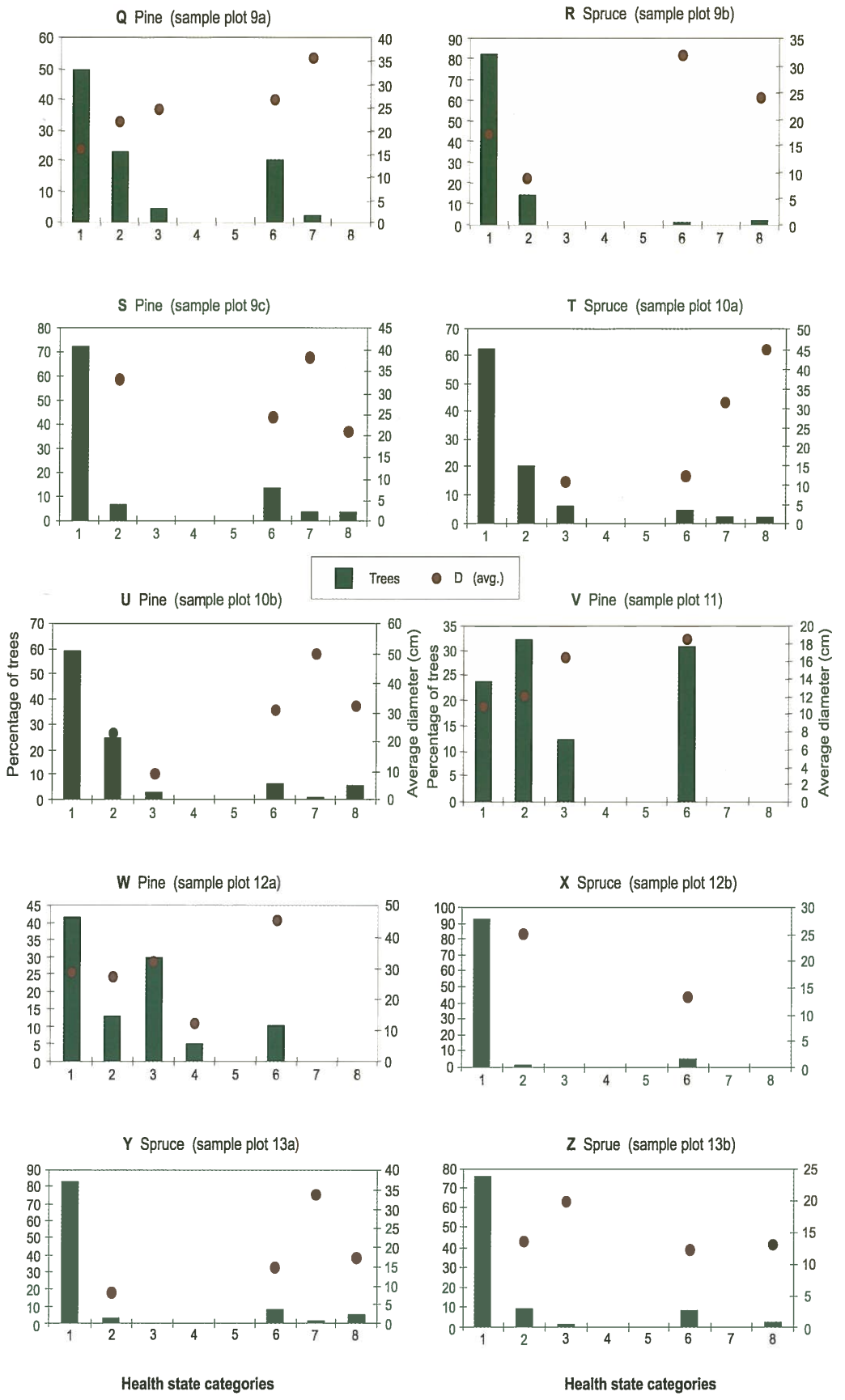


Fig. 7. Distribution of health state categories of trees and their mean diameter in different categories in the proposed Kalevala National Park.

Table 4. Distribution of trees according to state of health and ratio of dead trees at sampling plots in the territory of proposed Kalevala National Park

Sampling plot	Main tree species	Average diameter (cm)	Number of trees by category*								Ratio of dead trees (%)
			Total	1	2	3	4	5	6	7	8	
Vuokkiniemi Forestry District												
1	Pine	30,7	44	20	5	9	3	0	6	0	1	15,9
2a	Pine	26,8	77	54	10	4	0	0	9	0	0	11,6
2b	Spruce	24,4	84	51	6	9	11	0	2	1	4	8,3
3c	Pine	34	93	76	5	3	0	0	7	0	2	9,7
3a	Pine	20,9	113	86	8	3	1	0	13	0	2	13,3
3b	Pine	24,3	82	61	6	1	1	0	12	0	1	15,8
4a	Pine	28,6	91	65	5	7	1	0	12	0	1	14,2
4b	Pine	22,7	98	3	1	79	2	0	13	0	0	13,3
4c	Pine	48,5	107	0	23	42	30	1	11	0	0	11,2
4d	Pine	37,4	114	0	99	13	0	0	2	0	0	1,7
5a	Pine	28,8	61	42	5	0	0	0	10	2	2	22,9
5b	Spruce	17,9	111	88	3	4	0	0	12	2	2	14,4
5c	Spruce	11,7	48	37	6	0	0	0	4	1	0	10,4
10b	Pine	27,9	74	44	18	2	0	0	5	1	4	13,5
10a	Spruce	21,5	102	64	21	6	0	0	5	3	3	10,8
11	Pine	14,4	71	17	23	9	0	0	22	0	0	30,9
13a	Spruce	19,3	109	90	3	0	0	0	9	1	6	14,7
13b	Spruce	15,2	75	57	7	1	0	0	7	0	3	13,3
Vuonninen Forestry District												
7a	Pine	34,1	63	0	5	31	7	0	20	0	0	31,7
7b	Pine	25,5	98	21	25	25	13	1	12	0	1	14,3
7c	Pine	27,4	78	0	9	28	26	0	15	0	0	19,2
9a	Pine	24,8	44	22	10	2	0	0	9	1	0	22,7
9b	Spruce	20,3	83	68	12	0	0	0	1	0	2	3,6
9c	Pine	28,4	29	21	2	0	0	0	4	1	1	20,7
Latvajärvi Forestry District												
12a	Pine	28,8	77	32	10	23	4	0	8	0	0	10,4
12b	Spruce	19,5	83	77	1	0	0	0	5	0	0	6

* Category of tree condition: 1– healthy , 2 – weakened, 3 – profoundly weakened, 4 –dying, 5 – recently died, 6 – snags, 7 – windthrow, 8 – windbreak.

Pine stands

Observations indicate that the pine forests of the areas surveyed within Paanajärvi National Park are in a relatively good state of health (Table 3). The proportion of dead trees varies from 5,4 % to 27 % with the highest percentages observed on the pine covered mire (plot 6c). In sites on mineral soils the proportion of dead trees is

also relatively high, varying between 14,6 % and 19,1 %, with the exception of one plot (6a) where it was less than 6 %. The main component of dead trees comprises old standing trees with lost bark. On most of the sampling plots dead pines are, in general, larger than living ones. This indicates a process of natural mortality of the oldest trees. Four out of five sampling plots are characterised by high numbers of slightly weakened trees of relatively large girth (Fig. 6 E, G, I, K). All these facts evidence normal processes of forest development, a phenomenon peculiar to untouched stands displaying an undisturbed structure.

In Kalevala park the ratio of dead trees on sampling plots varies from 1,7 % to 31,7 % (Table 4). As is the case at Paanajärvi, the majority of dead trees (Fig. 7A, B, D–K, N–Q, S, U–W) consist of old snags of large diameter, without bark and with long–standing signs of insects galleries. The accumulation of such trees indicates that no forest management has been practised in the area for a long period of time. Forest fires have made an even greater mark at Kalevala than in Paanajärvi. On the majority of the sampling plots the most common cause of mortality of trees is the repeated occurrence of forest fires, as evidenced by living trees with scars on their trunks.

Six sampling plots containing trees bearing signs of resin extraction demand special attention as, according to current local forestry policy, they are due to be felled in the near future. Four of these plots (4b, 7a,b,c) contain sites of resin extraction which was carried out some 10 – 15 years ago. The proportion of dead trees on these plots is the highest for all the surveyed sites at Kalevala and most of the living trees are weakened (Fig. 6 H, N–P). In contrast, in compartment 142 of Vuokkiniemi Forestry District (plots 4 c, d) pines have been subjected to more recent resin extraction (i.e. 2 – 3 years ago). The preliminary treatment of the trunks with sulphuric acid has resulted in yellow wounds which have scarcely managed to heal (Fig. 8). In spite of this, the mortality rate on plots 4 C and 4 D proved to be less even than the average for the whole surveyed territory, the figures being 1,7 % and 11,2 % respectively. This fact may possibly be explained by the exceptionally high quality of the pines, the average trunk diameters of which being between 37,4 cm and 48,5 cm. On the other hand, the large proportion of weakened trees indicates an increased mortality in the near future, a prediction which appears to be justified by observation of the plots 4b and 7a–c. However, this process is usually slow and does not necessarily lead to deterioration of the entire stand. Unfortunately, the location close to a road which was recently constructed for felling and wood transportation purposes makes the inclusion of these sites in the proposed national park problematic.

Fig. 8. Traces of resin extraction in pines in the proposed Kalevala National Park.

Occurrence of potential forest pests

Neither signs of insect epidemics nor symptoms of forest decline due to insect pests have been observed in either areas. Signs of the heavy damage caused by *Neodiprion sertifer* Geoffr. in the pine forests of the River Oulanka valley in Paanajärvi, as cited by Dyakonov (1998), were also not observed. Thus, the old growth forests studied can in no way be considered as dispersal centres of insect pests. On the contrary, they exemplify balanced natural forest ecosystems.

Practically all the dead trees in both areas studied showed signs of insect colonisation. Quantitative data indicates the occurrence of insects belonging to groups which comprise potential pests. These include Scolytidae, Cerambycidae, Buprestidae, Curculionidae (Coleoptera) and Siricidae (Hymenoptera) (Table 5, 6). As a rule, galleries and larvae of potential pest species were encountered in trees which had already died of other causes. The sole exception to this was signs colonisation of *Dendroctonus micans,* as observed on almost all sampling plots in both pine and spruce stands in Paanajärvi and on half of the plots at Kalevala. In most cases galleries of *D.micans* were recorded on dead trees but on some plots we also found a few weakened old spruces and pines colonised by the species. In the area of the proposed Kalevala National Park it was observed on 200 – 220 year old pines in *Sphagnum* type forest and on 160 year old spruce in *Myrtillus* type spruce forest, where between 2 % and 5 % of living trees were infested. In the Paanajärvi area larvae of *D.micans* were encountered under the bark of profoundly weakened individual pines on two sampling plots (6a and 7a) in 220 year old stands of old growth *Cladonia* type forest. This species is known in Karelia as a pest of pine plantations growing on drained bogs (Uzenbaev & Krutov 1991) and of natural pine stands growing in highly moist conditions (Mozolevskaya et al. 1991). Colonisation of old living pines and spruces by *D.micans* has also been recorded in old growth forests growing on mineral soils in southern Karelia (Yakovlev 1996).

Table 5. Occurrence of Scolytidae, Cerambycidae, Buprestidae and Curculionidae (Coleoptera), and Siricidae (Hymenoptera) in dead pine trees at the sampling sites in Paanajärvi and Kalevala national parks. Species known as potential forest pests are marked by an asterisk.

Species	Percentage of sampling sites		Percentage of colonised dead trees	
	Paanajärvi	Kalevala	Paanajärvi	Kalevala
Scolytidae				
* Dendroctonus micans	80	38,9	25,0	7,3
* Tomicus piniperda	100	100	100	89,9
* Tomicus minor	100	100	72,7	81,7
Hylurgops palliatus	40	72,2	6,8	36,2
Hylastes brunneus	40	66,7	6,8	25,7
Dryocoetes sp.	20	66,7	4,5	28,0
* Trypodendron lineatum	80	94,4	36,4	70,6
Pityogenes sp.	80	22,2	9,1	8,3
* Ips acuminatus	40	5,6	4,5	0,5
Cerambycidae				
Arhopalus sp.	40	27,8	13,6	9,2
Rhagium inquisitor	100	100	22,7	52,8
Callidium sp.	20	55,6	2,3	28,4
Pogonocherus fasciculatus	60	66,7	13,6	36,7
Leptura sp.	20	33,3	4,5	6,4
Curculionidae				
* Pissodes sp.	80	77,8	13,6	20,2
Rhyncolus sp.	100	50,0	36,4	12,4
Hylobius abietis	20	11,2	4,5	8,3
Buprestidae				
* Melanophila cyanea	20	0,0	6,8	0,0
Siricidae	20	5,6	2,3	0,9

Table 6. Occurrence of Scolytidae, Cerambycidae, Buprestidae and Curculionidae (Coleoptera), and Siricidae (Hymenoptera) in dead spruce trees at the sample sites in Paanajärvi and Kalevala national parks. Species known as potential forest pests are marked by an asterisk.

Species	Percentage of sampling sites		Percentage of colonised dead trees	
	Paanajärvi	Kalevala	Paanajärvi	Kalevala
Scolytidae				
* Dendroctonus micans	100	55.6	26.4	23.1
Hylurgops glabratus	14.3	33.3	3.8	30.8
Hylurgops palliatus	57.1	77.8	9.4	30.8
Hylastes cunicularius	14.3	33.3	5.7	13.5
Xylechinus pilosus	42.9	88.9	9.4	53.8
Polygraphus sp	100	100	30.2	53.8
* Trypodendron lineatum	42.9	88.9	3.8	34.6
Micrographus sp.	28.6	0	3.8	0
* Pityogenes sp.	0	77.8	0	42.3
* Ips amitinus	14.3	0	1.9	0
* Ips typographus	0	33.3	0.0	13.5
Dryocoetes sp.	42.9	77.8	7.5	21.2
Crypturgus sp.	28.6	44.4	3.8	11.5
Phloethribus spinosulus	14.3	33.3	3.8	13.5
Cerambycidae				
* Tetropium sp.	100	100	26.4	46.2
Rhagium inquisitor	57.1	88.9	17.0	32.7
Callidium sp.	42.9	44.4	7.5	11.5
Pogonocherus fasciculatus	28.6	55.6	5.7	23.1
Molorchus minor	28.6	33.3	3.8	11.5
Buprestidae				
Anthaxia quadripunctata	0	22.2	0	11,5
Curculionidae				
* Pissodes sp.	42.9	55.6	9.4	23.1
Rhyncolus sp.	57.1	33.3	7.5	11.5
Melandryidae	42.9	66.7	11.3	26.9
Siricidae	14.3	22.2	1.9	9.6

Dead pine trees on all sampling plots in both areas usually exhibit traces of colonisation by subcortical and wood–boring beetles (Table 5). Some of these, such as *Tomicus piniperda, T. minor, Ips acuminatus* (Scolytidae), *Pissodes* species (Curculionidae) and *Melanophila cyanea* (Buprestidae), are also considered to be potential pests of living trees. In old pine forests we also occasionally observed large, outwardly healthy pines of 200 years and more which had been colonised by *Tomicus minor* and weevils of the genus *Pissodes*. The aggressiveness of these species is well known. However, cases in which they infest weakened trees in the main canopy level seem to be very rare in Karelia. In Kalevala park apparently healthy colonised trees were observed on the four pine dominated sampling plots in compartments 4 and 9 of Ladvozero, and 157 and 158 of Voknavolok forestry districts. The proportion of living pines damaged by the above species was, however, quite low (2 % – 8 %). On plots adjacent to an extensive area of clear-fell in compartment 9 the larvae of *Hylobius abietis* and *Hylastes* spp., usually unable to colonise living trees, were found on the roots of old, weakened individual pines of average trunk diameter 50 cm or more. In Paanajärvi National Park on two sampling plots (compartments 90 and 94) we found old pines of great stature and of over 250 years inhabited by the larvae of *Tomicus piniperda* and *T.minor*. It would appear that such old trees gradually lose their ability to resist infestation. Thus, the infestation of certain old individuals by the most active pioneer species of bark beetles is a common phenomenon in stands possessing a diverse age structure.

Several species observed under the bark of spruce are known either as pioneer invaders capable of inhabiting vigorous trees and of causing their death (*Ips typographus, I. amitinus, Pityogenes chalcographus, Tetropium castaneum, T.fuscum)* or as potentially dangerous pests of spruce timber (*Trypodendron lineatum, Monochamus* species, *Xeris spectrum, Urocerus gigas*). However, the larvae galleries of these species were encountered only on dead trees. Neither signs of successful colonisation of living spruce by these potential trunk pests nor outbreaks of herbivorous insects were recorded. *Ips typographus* and *Pityogenes chalcographus* were not observed on any of the sampling plots. We did, however, find them on fresh windthrows and windbreaks of over 10 cm diameter at most of the study sites outside of the plots. Nevertheless, these species are less abundant in the areas surveyed than in southern Karelia. Other species of bark beetles, such as *Hylurgops palliatus, H.glabratus* and species of the genus *Dryocoetes,* known as secondary invaders which only colonise dead trees, were much more common on our sampling plots. We noted that the ecological niche of *Ips typographus* was often occupied here by *Hylurgops glabratus*. The latter usually prefers fallen trees but has been observed on several occasions on fresh snags of two or more metres height. In the microhabitats typical of *I.typographus* we also found the morphologically similar species *Ips amitinus*. Twenty years ago the northern distribution extreme of this species in Fennoscandia was approximately 63 degrees of latitude. However, it has since rapidly extended its range northwards (Lekander et al. 1977).

Dead standing spruces of narrow girth were most frequently colonised by *Xylechinus pilosus* while thicker individuals bore *Polygraphus poligraphus* together with species of *Tetropium*. Only the latter has been recorded in southern Karelia as a potential pest species (Shiperovich 1949). However, this recording has not yet been confirmed by subsequent investigations (Mozolevskaya et al. 1991, Yakovlev 1996). Exit holes of large cerambycid species of the genus *Monochamus* and of the horn–tails *Xeris spectrum* and *Urocerus gigas* were not frequently observed.

General characteristic of the entomofauna

Paanajärvi

Naturalists have always been attracted by the outstanding natural features of the Paanajärvi area. The history of entomological studies in the Paanajärvi region prior to 1940 has recently been summarised by Viramo (1998). The most comprehensive studies were conducted in the western part of the area which formerly belonged to Finland (Renkonen 1938, Krogerus 1938, 1960, Platonoff 1943), while studies of the eastern part have been markedly less thorough. Since World War II almost no new entomological records have been collected from the area with the sole exception of those concerning aquatic insects inhabiting the streams running into Lake Paanajärvi (Huhta et al. 1993).

A total of 382 species belonging to 8 orders and 92 families of insects found in the research area is listed in the Appendix. A number of interesting finds are worthy of special mention.

Coleoptera

Most of the beetle samples were collected by hand. Some species were found only as larvae or were identified on the basis of larvae galleries. No window trapping was conducted.

In total 161 species of 37 families of Coleoptera were identified. Of these no less than fifty five species were recorded for the first time at Paanajärvi (Table 7) in spite of an extensive existing body of knowledge of local beetle fauna provided by the comprehensive study by Platonoff (1943). Of these *Hylobius sibiricus* Egorov (Curculionidae) had not previously been recorded anywhere in Fennoscandia while the recording of *Trypophloeus bispinulus* was the first ever in Russian Karelia.

Inspection of dead trees yielded a range of subcortical species. Pines were most often colonised by the bark beetles *Tomicus piniperda, T.minor, Trypodendron lineatum* and *Hylastes brunneus.* Other bark beetle species such as *Pityogenes quadridens, P. bidentatus,* and *Crypturgus cinereus* were less common. Such species as *Pityogenes irkutensis, Pityophthorus lichtensteinii, Ips acuminatus* and *Orthotomicus suturalis* were found on individual pines. The galleries of the longhorn beetles *Arhopalus rusticus, Acanthocinus aedilis* and species of *Leptura* were rather frequently encountered. On more rotten trunks, especially at the basal sections, *Pytho depressus, Rhagium inquisitor* and *Harminius undulatus* were prolific. In some sites, under the bark of pines, the rarer *Boros schneideri* was observed.

On spruce we found several species of Scolytidae. *Hylurgops palliatus, H. glabratus,* species of *Dryocoetes, Polygraphus poligraphus, Trypodendron lineatum, Xylechinus pilosus* and *Phloetribus spinosulus* were amongst those most commonly encountered whereas *Polygraphus subopacus, Pityophthorus micrographus,* and *Pityogenes saalasi* were found on single trees.

Old dead pine and spruce were frequently inhabited by members of the Melandryidae family (mainly *Xylita laevigata*) and weevils of the genus *Rhyncolus*, which are, however, less abundant here than in the middle taiga subzone. Under the bark of thick fallen spruces colonised by Scolytidae we recorded the larvae of *Pytho depressus* and *Pytho kolwensis*.

The complex of xylophilous insects on deciduous trees seems to be rather poor in comparison with those found in more southerly regions of Karelia. Only a few species, such as *Hylecoetus dermestoides, Trypodendron signatum and Scolytus ratzeburgii* were common throughout the area.

The hand picking of insects from under the bark of decaying trunks and from the fruiting bodies of *Fomes fomentarius, Fomitopsis pinicola, Piptoporus betulinus* and *Climacocystis borealis* species of bracket fungi yielded a variety of mycetophagous and myxomycetophagous beetles, among which the species of Leiodidae, Nitidulidae, Latridiidae and Cisidae were the most diverse. About one third of them, namely, *Agathidium rotundatum, A. confusum, A. nigripenne, A. pisanum, Epuraea deubeli, E. angustula, E. silacea, E. contractula, Latridius hirtus, Enicmus rugosus, Cis comptus, Ropalodontus strandi* and *Octotemnus glabriculus,* had not previously been found in the Paanajärvi area.

Diptera

Using Malaise traps and sweep nets a total of 657 individuals were caught. About 160 species from 27 families of Diptera were identified. The Mycetophilidae family dominated, accounting for 76 species while the numbers of species of several other families (Tipulidae, Bolitophilidae, Keroplatidae, Empididae, Syrphidae) approached ten. Unlike in Kalevala National Park, we did not find any species exhibiting a typically northern distribution.

Hymenoptera

In total, 42 species belonging to 12 families were identified. Some of these (e.g. *Bombus balteatus, B. lapponicus*) display a typical northern distribution and are not known in other Karelian regions while others are rather common throughout Karelia. Several species were recorded for the first time in Karelian territory.

Other orders

Other insect orders were not studied in any great depth. However, a total of 17 species from 5 insect orders were identified.

Table 7. Number of Coleoptera species added to faunistic list of Paanajärvi area in 1993-1998.

Families	Species		
	Previous data	Added in 1993-98	Total
Carabidae	81	2	83
Leiodidae	13	4	17
Silphidae	4	3	7
Sphaeritidae	0	1	1
Histeridae	3	1	4
Elateridae	30	2	32
Buprestidae	4	1	5
Anobiidae	2	3	5
Lymexylidae	1	1	2
Cleridae	2	1	3
Nitidulidae	16	5	21
Rhizophagidae	4	1	5
Endomychidae	1	1	2
Corylophidae	1	1	2
Latridiidae	14	2	16
Cerylonidae	1	1	2
Byturidae	0	1	1
Cisidae	2	3	5
Oedemeridae	0	1	1
Pythidae	2	1	3
Boridae	0	1	1
Melandryidae	1	2	3
Cerambycidae	29	2	31
Curculionidae	46	2	48
Scolytidae	21	12	33

Kalevala

Very little is known about the entomofauna of the vast area of Russian Karelia belonging to the biological province *Karelia pomorica occidentalis,* which stretches from the White Sea in the east, bordering *Karelia keretina* in the north and extending west as far as the Finnish border. By contrast, the adjacent areas in Finland have been well studied by both the Oulanka Biological Station, a department of the University of Oulu, and by numerous private naturalists. Situated in the western part of *Karelia pomorica occidentalis,* there are no previous records of insects available for the territory of the proposed Kalevala National Park. The only source of comparison is data from the well–studied biological province to the north–west of Kalevala *Regio kuusamoensis,* or Koillismaa, in north–eastern Finland. Koilismaa has for many decades been the target of numerous field trips undertaken by significant numbers of entomologists (Muona & Viramo 1986, Viramo 1996).

A total of 501 species belonging to 9 orders and 109 families were identified (see Appendix).

Coleoptera. The combined techniques of hand picking together with window and trunk window trapping yielded a total catch of 1396 individuals. In all, 179 species from 41 families have so far been identified. Those species identified comprise, of course, only a fraction of the entire beetle fauna of the area. For comparison, the list of Coleoptera recorded from the neighbouring Finnish area of Koillismaa area runs to no less than 1417 species (Viramo 1996).

Window trapping was performed in only a few study areas situated along the southern border of the proposed park. Owing to the traps being set close to weakened or dead trees, a prevalence of species associated with dead wood and wood-rotting fungi was recorded. The greatest diversity was amongst the families of Scolytidae (27 species), Cerambycidae (22), Elateridae (14), Curculionidae (11), Leiodidae (9) and Anobiidae (7). In terms of the number of individuals caught with window traps the Scolytidae family was again the most numerous. It was represented by 439 specimens, of which *Hylastes cunicularius*, *Hylastes brunneus*, *Hylurgops palliatus*, *Dryocoetes autographus* and *Trypodendron signatum* were the most commonly encountered. These are typical species for middle and north taiga forests in Karelia (Yakovlev 1996, Yakovlev et al. 1998). Several other families were also quite prolific, in particular Erotylidae 221 individuals, mostly made up of *Triplax russica*, Staphylinidae 163, Rhizophagidae 138 and Leiodidae 82 individuals. In comparison with more southern areas of Karelia the Elateridae family was rather uncommon although, nevertheless, diverse. Other families occurred less frequently in the material.

Diptera. 3905 individuals were collected using Malaise traps and sweep netting. In total, 248 species belonging to 40 Diptera families have been identified. The structure of the fauna proved to be rather similar to that of Paanajärvi park. Most diverse were the Fungus gnats (Mycetophilidae), 91 species in all. Other groups were not so numerous. Only a few families (Limoniidae, Empididae, Syrphidae and Scatophagidae) were represented by more than ten species.

One characteristic feature is the presence of some species exhibiting northern-type distribution. These include several species of the Empididae family, namely, *Tachypeza winthemi*, *Euthyneura albipennis* (the generally accepted distribution ranges of these two species do not extend southward beyond the southern borders of Murmansk province), *Platypalpus confinis*, and the fungus gnat *Boletina borealis*. One particular group of species seldom encountered in Fennoscandia was also recorded.

All above–mentioned Diptera species are typical forest inhabitants, either directly associated with dead wood, or predating on other wood–dwelling invertebrates. The biology of this group of insects is, in general, little known (Yakovlev 1994). However, according to recent studies in Norway (Økland 1994) certain species of fungus gnats, in particular, *Apolephthisa subincana*, *Boletina basalis* and *B.nigrofusca*, appear to be confined to old growth forests. Analysis of the distribution of these species in Karelia appears to confirms this hypothesis.

Hymenoptera. 905 individuals (51 species) of Hymenoptera were caught using Malaise traps and sweep–netting. Practically all recorded species are typical of the northern taiga subzone. In comparison with that of the southern taiga, the Hymenoptera fauna here is considerably impoverished. Among the most abundant species attention should be drawn to the ant species *Formica aquilonia*, the colonies of which were observed practically everywhere. Catches of this species in window traps were particularly numerous (over 100 specimens per trap), and were by far the most commonly encountered of all the insect groups. The presence of large numbers of ant nests and the high population density of this predatory species in general determines in many respects the sanitary state of the sites studied. Also worthy of note among the other Hymenoptera species are the bumblebee *Bombus*

jonellus and the parasitoid wasp *Helictes borealis*, each of which was collected in quantities of tens. Other species were mostly represented by individual specimens. Inside the thick bark of pines the digger wasp *Pemphredon lugubris* (Sphecidae) was occasionally encountered.

Other orders. Other insect orders were not studied in any great depth. Nevertheless, 23 species belonging to 6 orders were recorded during the course of the field study. The butterfly fauna (Lepidoptera, Rhopalocera) of the area appears to be profoundly impoverished in comparison with southern parts of Karelia. We observed only single individuals of the families Lycaenidae, Pieridae, Papilionidae and Nymphalidae, which were mostly encountered in anthropogenic landscapes such abandoned farms and hayfields. The dragonfly fauna (Odonata) was, by contrast, much richer, the majority of species encountered (*Cordulegaster boltoni, Pyrrhosoma nymphula, Leucorrhinia dubia*) having a typical northern distribution. These predatory insects were often observed by the shores of the numerous small lakes and ponds. The forest cockroach *Ectobius sylvesrtis* was highly prolific throughout the entire area under study. Noteworthy among the Orthoptera encountered is the tetrigid *Tetrix bipunctatus,* the range of which is spread rather far to the north.

Records of rare, threatened and otherwise remarkable insect species

Insect species considered to be rare or threatened in Karelia and Finland have been found in the study areas. We have also found several other insect species which seem to be confined to old growth forests and for this reason may be used as indicators of the conservational value of forest habitats (Table 8). Two of these species, *Trypophloeus bispinulus* (Scolytidae) and *Hylobius albosparsus* (Curculionidae) have never previously been recorded in Russian Karelia, the latter, indeed, appearing for the first time in the whole of Fennoscandia. Protection status for these species is now being sought.

A more detailed description of the records of the most remarkable species encountered is given below. Collecting sites located in the proposed Kalevala National Park are indicated by the following abbreviations: Vok: Vuokkiniemi Forestry District, Voi: Vuonninen Forestry District, Lad: Latvajärvi Forestry District. For compartment numbers see the map (Fig. 5). Species marked with a single asterisk are considered to be threatened according to the National Red Data Book of Karelia (Ivanter & Kuznetsov eds., 1995) while those with two asterisks are included in the Finnish Red Data Book (Rassi et al., 1992).

Mecoptera

Boreus hyemalis L. – Lad (compartment 5). Comparatively rare species occasionally recorded in Karelia but not known among Finnish fauna.

Hemiptera

** *Aradus pictus* Bar. – Vok (compartment 142). Subcortical species, associated with pine. Of infrequent occurrence in Russian Karelia.

Lepidoptera

Vanessa atalanta L. – Vartiolampi (Paanajärvi area). A migrant species seldom appearing in northern Karelia. In 1998 the species was fairly common throughout southern Karelia.

* *Papilio machaon* L. – Voi (compartment 178), Tavajoki (Paanajärvi area). Widely distributed but scarce throughout Karelia and the Murmansk district. Included in the Red Data Book of the Russian Federation and, for this reason, in the Red Data Book of the Republic of Karelia (Ivanter & Kuznetsov 1995).

Coleoptera

* ** *Lacon fasciatus* (L.) – Voi (compartment 159). A rare species living in the rotten wood of both coniferous and deciduous trees infected by fungi. An imago was found under the bark at the base part of an old dead pine.

Ampedus erythrogonus (Mull.) – Vok (compartment 9). Two individuals were caught in a window trap. The species seems to be widely distributed in southern Karelia but not in the north. Reported from Oulanka National Park, Finland (Muona & Viramo 1986), but not in Paanajärvi.

** *Melanophila cyanea* F. – Jungojärvi (Paanajärvi area). Larval galleries have been found under bark and in the surface layer of wood of several standing dead pines in *Cladonia* type forests. No previous recordings had ever been made in the Paanajärvi area. This species is rare even in southern parts of Karelia. Therefore, our observation, based only on larvae galleries, needs to be confirmed by a positive identification of an imago. However, the existence *M. cyanea* in the vast areas of pine forests of Paanajärvi seems plausible since the species has been recently found even further north in the Murmansk district near Kandalaksha (Mozolevskaya & Sharapa 1996).

** *Peltis grossa* (L.) – Lad (compartment181). This species experienced a sharp decline in Finland and Sweden over recent decades. In southern Karelia it is still common. The larvae develop in the dead wood of deciduous trees infected by the fungi *Fomes fomentarius* and *Fomitopsis pinicola.*

Lasconotus jelskii (Wank). – Vok (compartment 142). One individual was collected with a window trap. Resides under the bark of spruce and is a predator of Scolytidae. A rare species in Karelia, recorded only in the westernmost areas.

Epuraea contractula J.Sahlb. Mutkalampi, Oulakajoki, Vartiolampi, Olenii Bor (Paanajärvi area). Imagos were found on the upper surface of the fruiting bodies of *Fomes fomentarius*. The most abundant of the *Epuraea* species collected in Paanajärvi area. According to Muona & Viramo (1986) uncommon in the Koillismaa biological province.

Ipidia binotata Reitter. – Voi (compartment 178). Only once found near Lake Levi in Kalevala park and not at all in the Paanajärvi area. A typical old forest species with a southerly distribution (Rutanen & Kashevarov 1997). Very common in southern regions of Russian Karelia (Yakovlev 1996, Yakovlev et al. 1998)

Cerylon deplanatum Gyll. – Päänuorunen (Paanajärvi area). One individual was found under the rotten bark of an aspen in a herb-rich spruce-dominated forest on the shore of Lake Mustalampi near to the top of Päänuorunen Fell. A fairly uncommon species, not previously recorded in either Paanajärvi or neighbouring areas.

Octotemnus glabriculus (Gyll.) – Astervajärvi and Päänuorunen (Paanajärvi area); *Ropalodontus strandi* (Lohse) – Olenii Bor (Paanajärvi area). Both species were found as imagos in the old, dried up fruiting bodies of the wood growing fungi *Trichaptum sp.* and *Fomes fomentarius*. They were recorded for the first time in the Paanajärvi area.

Calopus serraticornis (L.) – Vok (compartment 184). The larvae of this species develop in the rotten basal parts of dead spruces. Widely distributed in southern Russian Karelia (Yakovlev 1996), commonly caught in window traps in the Ilomantsi area, Eastern Finland (Yakovlev et al. 1998) but not recorded in northern areas.

* ** *Pytho kolwensis* Sahlb. – Mutkalampi and Päänuorunen (Paanajärvi area), Vok (compartments 109,177,178), Voi (compartment 157), Lad (compartment 7). The larvae develop under the bark of fallen spruces of large girth, mostly in moist spruce forests with plenty of windfall. The species, apparently, has li-

mited dispersal abilities and is not capable of surviving in managed forests. In Finland only a few small populations are known to exist (Rassi et al. 1986) whereas in Karelia the species is prolific in favourable places.

* ** *Boros schneideri* (Panz.). – Olenii Bor, Jungojärvi and Tsypringa (Paanajärvi area), Vok (compartments 136, 140, 173). Larvae develop under the bark of standing dead pines. The species is rare and confined to old stands.

Stenotrachelus aeneus (Paykull) – Lad (compartment 5). The species develops in the rotten wood of both deciduous and coniferous trees. A rare species recorded only for the second time in Karelia.

Corticeus fraxini (Kugelann) – Lad (compartment 9). Dwells in the galleries of Scolytidae under the thick bark of dying pines. A rare species confined to old pine forests.

Mycetochara obscura (Zett). – Lad (compartment 9), Vok (compartment 142). Resides under the bark of dead conifers, less commonly found in deciduous trees. Confined to old forests.

* ** *Melandrya dubia* (Schaller) – Olenii bor and Jungojärvi (Paanajärvi area), Lad (compartment 5), Vok (compartment 136). A rather rare species usually encountered in forests with plenty of dead birch infected by *Fomes fomentarius*.

* ** *Tragosoma depsarium* L. – Voi (compartment 158). Old exit holes were found which apparently belong to this species. In spite of thorough searches in appropriate sites *T.depsarium* was not found anywhere in the Paanajärvi area. The beetle develops in the fallen trunks of thick pines which died when standing and have since fallen. The larvae reside in the border between layers of dry and decaying wood. In 1950–60s this species was observed all over southern Karelia (Yakovlev et al. 1986). However, during recent years, apparently as a consequence of the disappearance of areas of old pine forest, populations have fallen sharply. Today the individual local populations of the Kivach reserve are the only ones known to us.

Evodinus borealis (Gill.) – Astervajoki (Paanajärvi area). Collected on a spruce trunk. The larvae develop in coniferous trees. Fairly common in southern Russian Karelia but seems to be rare in the north. Recorded in Paanajärvi (Viramo in prep.) and in the adjacent area of Oulanka National Park (Muona & Viramo 1986).

Necydalis major L. Oulankajoki (Paanajärvi area). Larvae were found in the standing part of a huge broken trunk of birch. The larvae develop in the soft wood of large dead aspens, birches and willows. A species characteristic of old forests, common in southerly areas but rare in the north.

Hylobius sibiricus Egorov sp.n. [*albosparsus* auct. nec Boh., 1845] – Mutkalampi (Paanajärvi area). One individual was found sitting on the trunk of an old spruce in a *Myrtillus* type spruce forest. The species was formerly known as *Hylobius albosparsus* Boh. but has recently been redescribed by Egorov (1996) as a new species. *Hylobius albosparsus* Boh. is an eastern boreal species closely related to *Hylobius piceus* (Deg.). It had not been previously recorded in Fennoscandia.

Pityogenes saalasi Egg. – Mutkalampi and Olenii bor (Paanajärvi area). Also recorded by Platonoff (1943). The larvae develop under the bark of spruce. A typical species of old growth forests, fairly uncommon in southern part of Karelia.

Ips amitinus(Eichoff) – Olenii bor and Oulankajoki (Paanajärvi area). Several individuals were found under the bark of fallen spruce. A southern species which has recently invaded eastern Fennoscandia. In Finland it was captured for the first time in 1950. Then in 1973, after a period of over twenty years, it became common throughout the south of the country up as far as latitude 63 N (Lekander et al. 1977). In Russian Karelia too it has been obser-

ved only in southern areas up as far as the village of Voloma (between 63° and 64° N latitude) in the Mujejärvi district (Yakovlev et al. 1986). The species was not recorded during a previous inventory carried out in the 1950s by Titova (1959) of bark-beetles colonising young coniferous trees and felling residue of felling sites in southern and central Karelia.

Ips sexdentatus (Borner) – Vok (compartment 173). Typical large larvae galleries were found under the bark of huge pine logs at the site of a former wood store by the side of a local road in the Kalevala park. The species develops under the thick bark of recently fallen old pines and has become extremely rare in the forests of southern Karelia. It is still, however, frequently encountered in wood stores.

Trypophloeus bispinulus Egg. – Päänuorunen (Paanajärvi area). One individual was found under the bark of aspen in rich mixed forest on the northern shore of lake Mustalampi. The larvae develop under the bark of dead aspen. A rare species, associated with aspen. It had not previously been recorded in either Russian Karelia or the Paanajärvi area.

Pityogenes irkutensis Egg. — Nuorunen Fell (Paanajärvi area). Several individuals were found under the bark of broken pine. Recorded for the first time both in the Paanajärvi area and for the whole of the Kollismaa biological province.

Pityophthorus lichtensteinii (Ratz.) – Nuorunen Fell (Paanajärvi area). Several individuals were found under the bark of dead pines in a pine-dominated forest near the River Tavajoki. Not previously recorded in Paanajärvi.

Diptera

Mycomya karelica Väisänen – Vok (compartments 181, 184). There have only been a handful of previous recordings of this species in Finland, Poland and the Altai mountains (Zaitsev 1994).

Ectrepesthoneura bucera Plassmann – Vok (compartments 181, 184), Olenii Bor, Paanajärvi area. Only a few previous recordings in Karelia and Sweden (Zaitsev 1994).

Anaclileia dziedzickii Landr. – Jungojärvi (Paanajärvi area). A rare species, known only through a few recordings from Central Europe and the Vologda province of Russia (Zaitsev 1994).

Trichonta amica Gagné – Astervajärvi, Mutkalampi, Olenii Bor (Paanajärvi area). This is the first Palaearctic record of a species which was originally described in Canada (Gagné 1981).

Cordyla styliforceps (Bukowski) – Olenii Bor (Paanajärvi area). A species known earlier from areas of Southern Europe (Krimea, Portugal, Spain, Israel) and the Canary Islands (Chandler 1994, Chandler & Ribeiro 1995). It has also been found in other regions of Russian Karelia (unpublished records).

Diadocidia trispinosa Polevoi, *Sciophila balderi* Zaitzev et Økland, *Drepanocercus spinistylus* Søli, *Boletina jamalensis* Zaitsev – Vok (compartment 181), *Boletina onegensis* Polevoi – Vok (compartment 142), *B. cornuta* A.Zaitsev, *B. populina* Polevoi, *B. triangularis* Polevoi – Olenii Bor (Paanajärvi area), *Ectrepesthoneura tori* Zaitsev et Økland – Vok (compartment 181), *Dynatosoma dihaeta* Polevoi – Olenii Bor (Paanajärvi area), *Synplasta pseudingeniosa* A.Zaitsev – Mutkalampi (Paanajärvi area). These species have been recently described in Finland, Norway, the Yamal Peninsula and Karelia (Søli 1994, Zaitsev 1993, 1994, Zaitsev & Økland 1994, Polevoi 1995, Zaitsev & Polevoi 1995). Their distribution has not been sufficiently studied. That they have only recently been described suggests a confinement to certain habitat types. Scarce in Fennoscandia.

* *Xylophagus matsumurae* Miyat. – Vok (compartment 9). A rare species more common in eastern areas of the Palaearctic. The range of this species requires more detailed study. Only a few recordings are known from Karelia.

** *Sphecomyia vespiformis* Gorski – Kivakka Fell (Paanajärvi area). A large, wasp–like fly. A rare species found in Karelia for the first time.

** *Anomalochaeta guttipennis* (Zett.) – Vartiolampi (Paanajärvi area). A rare species distributed across the northern part of Europe. Not previously recorded in Karelia.

Hymenoptera

Bombus balteatus Dhlb., *Bombus lapponicus* F. – Nuorunen (Paanajärvi area). Both of these bumble–bee species display a typical northern distribution. Up to now these are the only recordings for the territory of Karelia.

Sapyga similis F. – Jungojärvi (Paanajärvi area). A rare species previously recorded at only three locations within Karelian territory.

Echthrus reluctator L. – Olenii bor (Paanajärvi area). Known as parasite of the saproxylic beetle *Saperda populnea* (Cerambycidae).

* *Odontocolon spinipes* Grav. – Vok (compartment 181), * *Xo rides brachylabis* Kriechb. – Nuorunen (Paanajärvi area), *Rhyssa persuasoria* L. – Vok (compartment 181). All these are comparatively rare species of parasitoid wasps from the Ichneumonidae family. They are confined to old spruce forests containing plenty of dead trees. Collected with traps set on the thick trunks of dead or profoundly weakened spruces inhabited by the larvae of horn-tails and longhorn beetles.

Assessment of the conservation value of the territory

Studies of the invertebrate fauna of protected areas of primeval nature are required in order to assess the conservational value of such areas, in particular with regard to the extent of their territory (Heliövaara & Väisänen 1984). From this point of view the findings of 25 insect species which can be considered as typical inhabitants or indicators of primeval forests (Table 8) is a significant achievement.

Among the saproxylic beetles observed in each of the areas two species, *Boros schneideri* (Boridae) and *Pytho kolwensis* (Pythidae), associated with the primeval forests of northern Europe deserve special attention. Namely, the populations of these two beetle species have seriously declined as a result of their exclusive dependence on old growth forests. *Boros schneideri* develops as larvae under the bark of standing dead pines already abandoned by bark beetles. In the taiga zone this species is apparently confined to extensive areas of old unmanaged pine forests. A very sharp drop in the population of *Boros schneideri* has been recorded in Sweden (Ehnstrom 1999) and Finland (Muona et al. 1998a) over the past one hundred years. A similar situation appears to exist in Russian Karelia where it has only been found in the best examples pine forests from the strictly protected nature reserves of Kivatsu and Kostamus (Yakovlev 1995) and the islands of the White Sea (Humala & Polevoi 1999).

The other species, *Pytho kolwensis*, is a specifically adapted to life in patches of cool, moist and shady forests in which large spruces dominate (Muona et al. 1998b). This too has experienced a similar fall in population during the past century in Finland where records kept since 1960 are restricted to a few areas, namely, the Pyhä–Häkki and Oulanka national parks, Lieksa and Pallosenvaara in Ilomantsi (Rassi et al. 1986). In Russian Karelia it still seems to be widespread in suitable places. In Finland both *B.schneideri* and *Pytho kolwensis* are included in the list of species placed under strict protection since 1997 according to the Nature Conservation Act and also in the Habitats directive (Kotiranta et al. 1998).

In addition, we found in both areas surveyed several insect species apparently confined to old growth forests, for which reason they may reliably be used as indicators of the conservational value of forest habitats (Table 8). Two of these had not previously been recorded in anywhere Russian Karelia (*Trypophloeus bispinulus*, Scolytidae) or even in the whole Fennoscandia (*Hylobius albosparsus*, Curculionidae).

In the Paanajärvi area the above mentioned species were found at all the sampling sites. Areas situated to the east of the national park, including some almost untouched pine–dominated forests in the vicinity of Lake Tsipringa, Paanajärvi and Päänuorunen Fell (at the Tsipringa and Päänuorunen sites), are of special interest because they are not protected. *Boros schneideri* is widely distributed in the pine forests of the Jungojärvi, Tsypringa and Päänuorunen sampling sites. *Pytho kolwensis* and *Trypophloeus bispinulus* were found in spruce forest at the Päänuorunen site. Consequently, it is strongly recommended that both the Tsipringa and Päänuorunen sites be added to the current territory of the national park. Furthermore, all adjacent areas to the north, and especially the north–west of Paanajärvi National Park, as well as those to the south between the rivers Oulanka and Tavanga river should be thoroughly surveyed.

Regarding the territory of the proposed Kalevala National Park, we pay special attention to the boundary areas to the south of the Lake Hoikkajärvi – River Kaba – Lake Pirttijärvi – River Vuokinjoki river–lake system (occupying compartments 113–115, 140–146 and 166–196 of the Vuokkiniemi Forestry District and the northernmost compartments 157–163 of the Vuonninen Forestry District) which are at serious risk of felling in the very near future. Indicator insect species have been found at all the sampling sites in these areas, as well as at Paanajärvi. *Boros schneideri* is widely distributed in the well preserved pine forests of the valleys of the rivers Kaba and Vuokinjoki (compartments 140, 173). Populations of *Pytho kolwensis* were found in spruce forests between lakes Vazhajärvi and Hoikkajärvi (compartments 177–178, Vuokkiniemi Forestry District), as well as in compartment 7 of the Latvajärvi Forestry District and in the valley of the River Kurzhma (compartments 157–158, Vuonninen Forestry District). The borderline of the proposed Kalevala National Park is not delineated yet, as well as the establishment of this National Park is still open question. It is our strongly held view that the findings of insect species indicating a high conservational value of forest habitat, particularly those included in the National Red Data Books of both Karelia and Finland, provide ample grounds for the inclusion of the territories surveyed into the protected area of the proposed national park. Furthermore, the adjacent areas of Latvajärvi and Vuonninen forestry districts would appear to require in–depth study in the near future.

Table 8. Insect species recommended as potential indicators of unspoilt boreal forest and their occurence in the areas surveyed. Numbers of study sites given according to Tables 1 and 2.

* species included in Red Data Book of the Karelian Republic (Ivanter & Kuznetsov, 1995).

** species included in Finnish Red Data Book (Rassi et al., 1992).

Species	Paanajärvi sites									Kalevala sites							
	1	3	4	6	7	8	9	10	11	2	3	4	6	8	9	12	13
HETEROPTERA																	
**Aradus pictus Bar												x					
COLEOPTERA																	
* *Lacon fasciatus* (L.)														x			
Ampedus erythrogonus (Mull.)																x	
Calopus serraticornis (L.)													x				
* ** *Melanophila cyanea* F.					x												
* ** *Peltis grossa* (L.)														x			
* ** *Pytho kolwensis* Sahlb.		x					x			x				x		x	x
* ** *Boros shneideri* (Panz.)				x	x	x					x	x					
Stenotrachelus aeneus (Payk.)																x	
** *Corticeus fraxini* (Kug.)																x	
Mycetochara obscura (Zett.)												x				x	
* ** *Melandrya dubia* (Schall.)				x	x							x				x	
* ***Tragosoma depsarium* L.														x			
Evodinus borealis (Gyll.)		x															
Necydalis major L.			x														
Hylobius sibiricus Egorov	x																
Pityogenes saalasi Egg.	x			x													
Ips sexdendentatus (Borner)											x						
Trypophloeus bispinulus Egg.							x										
Pityogenes irkutensis Egg.									x								
Pityophthorus lichtensteinii (Ratz.)									x								
HYMENOPTERA																	
* *Odontocolon spinipes* Grav.													x				
* *Xorides brachylabis* Kriechb									x	x							
Rhyssa persuasoria L.													x				
DIPTERA																	
Drepanocercus spinistylus Søli													x				
* *Xylophagus matsumurae* Miyat																x	

Acknowledgements

This study was supported by the EU LIFE fund (grant B4–3200/96/543). We are indebted to Dr. Raimo Heikkilä, Director of Friendship Park Research Centre, Kainuu Environment Centre, Kuhmo, for providing invaluable help in all aspects of our work, and to Dr. Juha Siitonen (Vantaa Research Centre, Finnish Forest Research Institute, Finland) for his valuable comments on the manuscript. Furthermore, the authors wish to thank Dr. Nikolai Nikitsky (Moscow University, Russia), and Dr. Siitonen for their help in the identification of the most difficult groups of Coleoptera.

References

Chandler, P.J. 1994: The fungus gnats of Israel (Diptera: Sciaroidea, excluding Sciaridae). – Israel Journal of Entomology 28: 1–100.

Chandler, P.J. & Ribeiro, E. 1995: The Sciaroidea (Diptera) (excluding Sciaridae) of the Atlantic islands (Canary Islands, Madeira and the Azores). – Sup. Bul. Mus. Mun. Funchal 3: 1–170.

Dyakonov, V. 1998: Condition of pine phytocoenoses in the eastern Paanajärvi National Park. – Oulanka Reports 19: 33–35.

Egorov, A.B. 1996: Family Curculionidae. – In: Text book for the identification of Russian Far East insects. (In Russian). Vol.III. Pt. 3, Vladivostok, "Dalnauka". 395 pp.

Ehnstrom, B. 1999: Red-listed beetles on Scotch pine (*Pinus sylvestris*) in Sweden. – In: Proceedings of the XXIV Nordic Congress of Entomology, Aug.8 – 11, 1997, Tartu, Estonia: 55–61. Univ. of Tartu, Inst of Zoology & Hydrobiology, Estonian Nat. Society. Tartu.

Gagné, R.J. 1981: A monograph of *Trichonta* with a model for the distribution of Holarctic Mycetophilidae (Diptera). – Techn. Bull. USDA 1638:1–64.

Gromtsev, A.N. (ed.) 1998: Materials on inventory of nature complexes and ecological feasibility study of Kalevala National Park. (In Russian). – Petrozavodsk. 44 pp.

Gromtsev, A.N. 1999: Climax forests of Karelia: nature features, present state and perspectives of conservation. – In: Volkov, A.D. &Gromtsev, A.N. (eds.), Climax forests of the European taiga zone: present state and perspectives of conservation: 21–26. Proc. of Int. Conference, 6 – 8 July 1999. Petrozavodsk.

Gromtsev, A.N., Kolomytsev, V.A. & Shelekhov, A.M. 1995: Landscape peculiarities and recreational assessment of Paanajärvi National Park. – In: Nature and ecosystems of Paanajärvi National Park: 7–18. Karelian Centre of RAS Petrozavodsk.

Heliövaara, K. & Väisänen, R. 1983: Environmental changes and flat bugs (Heteroptera, Aradidae and Aneuridae). Distribution and abundance in Eastern Fennoscandia. – Ann. Ent. Fenn. 49: 103–109.

Heliövaara, K. & Väisänen, R. 1984: Effects of modern forestry on north-western European invertebrates: a synthesis. – Acta Forestalia Fennica 189: 1–32.

Huhta, A., Kuusela, K. & Paasivirta, L. 1993: Notes on the zoobenthos of streams draining into Lake Paanajärvi. – Oulanka Reports 12: 87–89.

Humala, A. & Polevoi, A. 1999: On the insect fauna of the Karelian coast and islands of the White Sea – In: Gromtsev, A.N Krutov V.I.(eds.), Biodiversity inventories and studies in the areas of Karelian White Sea shore: 106–113. Karelian Res. Centre of RAS. Petrozavodsk.

Ivanter, E.V. & Kuznetsov, O.L. (eds.) 1996: Krasnaya Kniga Karelii. [Red Data Book of Karelia] (In Russian). – Ministry of ecol. nat. res. Republik. Kar., Res. Centre Rus. Acad. Sci., Petrozavodsk University of Petrozavodsk, "Karelia" 286 pp.

Kaila, L. 1993: A new method for collecting quantitative samples of insects associated with decaying wood or wood fungi. – Entomol. Fennica 4: 21–23.

Kaila, L., Martikainen, P., Punttila, P. & Yakovlev, E. 1994: Saproxylic beetles (Coleoptera) on dead birch trunks decayed by different polypore species. – Ann. Zool. Fennici 31: 97–107.

Kotiranta, H., Uotila, P., Sulkava, S. & Peltonen, S.L. (eds.) 1998: Red Data Book of East Fennoscandia. – Ministry of the Environment, Finnish Environment Institute & Botanical Museum, Finnish Museum of Natural History. Helsinki. 351 pp.

Krogerus, R. 1938: Parasitsteklar från torvmarkerna i Kuusamo-området. – Notulae Entomol. 18: 105–108.

Krogerus, R. 1960: Ökologische Studien über nordische Moorarthropoden. – Comment. Biol. 31(3): 1–238.

Krutov, V.I. & Gromtsev, A.N. (eds.) 1998: Inventory and biodiversity studies of the borderline zones of Republic of Karelia (In Russian) – Karelian Research Centre of RAS. Petrozavodsk. 166 pp.

Lekander, B., Bejer-Peterson, B., Kangas, E. & Bakke, A. 1977: The distribution of bark beetles in the Nordic countries. – Acta. Entomol. Fennica 32: 1–102.

Martikainen, P., Siitonen, J., Kaila, L., Nikula, A. & Punttila, P. 1996: Intensity of forest management and bark beetles in non-epidemic conditions: a comparison between Finnish and Russian Karelia. – J. Appl. Ent. 120: 257–264.

Mozolevskaya, E.G., Galasjeva, T.V. & Chemeris, M.V. 1991: Species composition and distribution peculiarities of xylophagous insects in Nature Reserve "Kivach" (In Russian with English summary). – Entomological researches in Nature Reserve "Kivach": 66–74. Petrozavodsk 1991.

Mozolevskaya, E.G., Galasjeva,T.V., Sokolova, E.S., Osipov, I.N. & Osipova, A.S. 1990: Organisation of forest health state monitoring in Nature reserves. Methodical recommendations (In Russian). – Puschino 1990. 29 pp.

Mozolevskaya, E.G., Kataev, O.A. & Sokolova, E.S. 1984: Methods in forest health state observation, trunk pests and forest diseases (In Russian). – Moscow. 152 pp.

Mozolevskaya, E.G., & Sharapa, T.V. 1996: Species composition of xylophagous insects in Murmansk province. – Entomol. Obozr. Vol. 75: 53–63.

Muona, J. Yakovlev, E. & Mannerkoski, I. 1998a: *Boros schneideri*. – In: Kotiranta, H. et al (eds.), Red Data Book of East Fennoscandia. Ministry of the Environment, Finnish Environment Institute & Botanical Museum, Finnish Museum of Natural History. Helsinki. P.327–328.

Muona, J. Yakovlev, E. & Mannerkoski, I. 1998b: *Pytho kolwensis*. – In: Kotiranta, H. et al (eds.) Red Data Book of East Fennoscandia: 326–327. Ministry of the Environment, Finnish Environment Institute & Botanical Museum, Finnish Museum of Natural History. Helsinki.

Muona, J. & Viramo, J. 1986: The Coleoptera of the Koillismaa area (Ks), North-East Finland – Oulanka reports 6: 3–50.

Økland, B. 1994: Mycetophilidae (Diptera), an insect group vulnerable for forestry practices? A comparison of clearcut, managed and semi-natural spruce forests in southern Norway. – Biodiversity and Conservation 3: 68–85.

Økland, B. 1995: Diversity patterns of two insect groups within spruce forests of southern Norway. Dr. scientarum theses 1995:21. – Agricultural University of Norway. Ås. 129 pp.

Ovaskainen, O. (ed.) 1998: Survey of old growth forests in North-West Russia. – Finnish Nature League publications 1: 1–100.

Platonoff, S. 1943: Zur Kenntnis der Käferfauna um den See Paanajärvi in Kuusamo, Nordfinnland. – Not. Entomol. 23:76–144.

Polevoi, A.V. 1995: New and poorly-known species of the families Bolitophilidae, Diadocidiidae and Keroplatidae from Eastern Fennoscandia (Diptera, Nematocera). – Zoosystematica Rossica 4: 177–182.

Rassi, P., Alanen, A., Kemppainen, E., Vickholm, M. & Väisänen, R. (eds.) 1986: Uhanalaisten eläinten ja kasvien suojelutoimikunnan mietintö. II Suomen uhanalaiset eläimet. (In Finnish). – Komiteanmietintö 1985:43. Ympäristöministeriö. Helsinki. 466 pp.

Rassi, P., Kaipiainen, H., Mannerkoski, I. & Ståhls, G. (eds.) 1992: Uhanalaisten eläinten ja kasvien seurantatoimikunnan mietinto. (In Finnish with English summary). – Komiteamietintö 1991:30. Ympäristöministeriö. Helsinki. 328 pp.

Renkonen, O. 1938: Statistisch-ökologische Untersuchungen über die terrestrische Käferwelt der finnischen Bruchmoore. – Ann. Zool. Soc. 'Vanamo'. 6: 1–226.

Rutanen, I. & Kashevarov, B. 1997: Coleoptera of the Nature Reserve Friendship with adjacent primeval forests. – In: Lindholm, Heikkilä, R. & Heikkilä, M. (eds.), Ecosystems, fauna and flora of the Finnish-Russian Nature Reserve Friendship. Finnish Environment 124: 257–294.

Shiperovich, V.J. 1949: The effect of insect pests on coniferous stands in forests reserve "Kivach". (In Russian). – Izv. Karel.-Fin. Research base of USSR Acad. Sci. 1: 20–31.

Siitonen, J. & Martikainen, P. 1994: Occurrence of rare and threatened insects living on decaying *Populus tremula*: a comparison between Finnish and Russian Karelia. – Scand. J. Forest Res.

Siitonen, J., Martikainen, P., Kaila, L., Nikula, A. & Punttila, P. 1995: Kovakuoriaislajiston monimuotoisuus eri tavoin käsitellyillä metsäalueilla Suomessa ja Karjalan tasavallassa. – In: Hanelius, S & Niemelä, P (eds.), Monimuotoisuus metsien hoidossa. Publications of the Finnish Forest Research Institute 564: 43–63.

Siitonen, J., Martikainen, P., Kaila, L., Mannerkoski, I., Rassi, P. & Rutanen I. 1996: New faunistic records of threatened saproxylic Coleoptera, Diptera, Heteroptera, Homoptera and Lepidoptera from the Republic of Karelia, Russia. – Entomol. Fennica 7: 69–76.

Silfverberg, H. 1992: Enumeratio Coleopterorum Fennoscandiae, Daniae et Baltiae. – Helsinki. 94 pp.

Speight M.C.D. 1989: Saproxylic invertebrates and their conservation. – Strasbourg: Council of Europe. 82 pp.

Søli G.E.E. 1994: Fungus gnats from Jostedalen, West Norway (Diptera; Diadocidiidae and Mycetophilidae) – Fauna Norv. Ser. B. 41: 1–12.

Titova, E.V. 1959: Bark beetles of the young coniferous trees in felling sites in Karelia. – In: Proceedings of Karelian Branch of USSR Academy of Sciences. Vol XVI Researches of reforestation in Karelia: 110–126. Petrozavodsk.

Townes, H. 1972: A light-weight Malaise trap. – Entomol. News 83: 239–247.

Uzenbajev S.D. & Krutov V.I. 1991: Bark beetle *Dendroctonus micans* Kug. (Coleoptera, Scolytidae) in Karelia. – Entomological researches in Nature Reserve "Kivach" (In Russian with English summary): 138–145. Petrozavodsk.

Viramo, J.1996: A check list of Insecta (excl.Diptera, Siphonaptera and Hymenoptera) of the biological province Koillismaa (Ks; Regio Kuusamoensis) – Oulangan biologisen aseman julkaisuja 4. 75 pp. (In Finnish).

Viramo, J. 1998: Trips by Finnish entomologists to the Paanajärvi. Kutsa region prior to 1940. – Oulanka Reports 19: 11–18.

Volkov, A.D., Gromtsev, A.N., Erukov, G.V., Karavaev, V.N., Kolomytsev, V.A., Kurhinen, Y.P., Rukosuev, S.I., Sazonov, S.V. & Schelekhov, A.M. 1995: Ecosystems of the north taiga landscapes (structure, dynamics). (In Russian). Petrozavodsk. Karelian Research Centre of RAS. 194 pp.

Väisänen, R., Biström, O. & Heliövaara, K. 1993: Sub-cortical Coleoptera in dead pines and spruces: is primeval species composition maintained in managed forests? – Biodiversity and Conservation 2: 95–113.

Yakovlev, E.B. 1994: Palaearctic Diptera associated with fungi and myxomycetes. (In Russian with English summary). – Petrozavodsk. Karelian Research Centre of RAS. 127 pp.

Yakovlev, E.B. 1995: *Boros schneideri* (Panz). – In: Ivanter, E.V. & Kuznetsov, O.L. (eds.), Krasnaya Kniga Karelii [Red Data Book of Karelia]: 245–246. – Ministry of ecol. nat. res. Republik Kar. Res. Centre Russ. Acad. Sci., Petrozavodsk University. Petrozavodsk, "Karelia". (In Russian).

Yakovlev, E.B. 1996: On the saproxylic Coleoptera complexes of unmanaged Karelian forests. – In: Krutov, V.I., Sinkevich, S.M. & Fedorets, N.G. (eds.), Problems of anthropogenic transformation of Karelian forest biogeocenoses: 139–166. (In Russian with English summary). Petrozavodsk. Karelian Research Centre of RAS.

Yakovlev, E.B. 1999: Studies of saproxylics and other insects in mature unmanaged forests of Russian Karelia. In: Toivonen,T., Koponen, S.&Kouki, J. (eds.) Luonto ja Yhteiskunta. Juhlakirja professori Pekka Niemelalle hanen tayttaessaan 50 vuotta. Tiedonantoja 89. University of Joensuu. Faculty of Forestry. P. 73–83.

Yakovlev, E.B. & Hokkanen, T. 1995: *Cyllodes ater* (Coleoptera, Nitidulidae) found again in Finland – Entomol. Fennica. 5: 203–204.

Yakovlev, E., Humala, A. & Polevoi, A. 1995: Records of threatened insects in South Russian Karelia since 1950. – Proceedings of the 9th international colloquium of the European Invertebrate Survey. Helsinki, 3–4 September 1993: 96–105. Helsinki. WWF Finland.

Yakovlev, E., Nikitsky, N. & Scherbakov, A. (in press): Coleoptera of old growth forests in Koitajoki area, Eastern Finland – In: Hokkanen, T.J. & Kurikka, O. (eds.), Koitajoki area biodiversity studies. Joensuu.

Yakovlev, E.B., Shorokhov, V.V. & Gorbunova, V.N. 1986: On the fauna of xylophagous Coleoptera of Karelia. – In: Yakovlev, E.B., & Uzenbajev, S.D. (eds.), Fauna and ecology of Karelian arthropods. (In Russian): 40–59. Petrozavodsk. Karelian Branch of USSR Acad. Sci.

Yakovlev, F.S. & Voronova, V.S. 1959: Forest types of Karelia. (In Russian). – Petrozavodsk. Karelian Branch of USSR Acad. Sci. 239 pp.

Zaitzev, A.I. 1993: Three new species of fungus gnats of the genera *Synplasta* Scuse and *Allodiopsis* Tuomik. (subgenus *Myrosia* Tuomik.) from Russia. – Lambillionea 93:215–218.

Zaitzev, A.I. 1994: The fungus gnat fauna of Russia and adjacent regions. (In Russian with English summary). – Moscow. 288 p.

Zaitzev, A.I. & Polevoi, A.V. 1995: New species of fungus gnats (Diptera: Mycetophilidae) from Kivach Nature Reserve. – Entomol. Fennica. 6: 185–195.

Zaitzev, A.I. & Økland, B. 1994: Four new species of fungus gnats from Norway (Diptera, Mycetophilidae). – Studia dipterologica. 1: 181–186.

Appendix

List of the insect species collected in Paanajärvi area and proposed Kalevala National Park

* - Only larvae have been found; ** - Only larvae galleries have been found; ? – questionable identifications.
Numbers (number of individuals) are given for trapping data and + sign for hand picking and literature records.

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
ODONATA				
Coenagrionidae				
Coenagrion hastulatum Charp.	-	+	1	+
Pyrrhosoma nymphula Sulzer			-	+
Calopterygidae				
Calopteryx virgo L.			-	+
Aeschnidae				
Aeschna juncea L.	-	+	-	+
A. grandis L.	-	+	-	
Cordulegasteridae				
Cordulegaster boltoni Don.			-	+
Corduliidae				
Cordulia aenea L.	-	+	-	
Somatochlora flavomaculata V.d.Lind.			-	+
Libellulidae				
Sympetrum danae Sulzer			-	+
Libellula quadrimaculata L.	-	+	-	+
Leucorrhinia dubia V.d.Lind.	-	+	-	
L. rubicunda L.	-	+	-	+
BLATTOPTERA				
Blatellidae				
Ectobius lapponicus L.	-	+	-	
E. sylvestris Poda	-	+	12	+
ORRTHOPTERA				
Tetrigidae				
Tetrix bipunctata L.	-	+	-	+
RAPHIDIOPTERA				
Raphidiidae				
Raphidia xanthostigma Schumm.	-	+	-	
MECOPTERA				
Boreidae				
Boreus hyemalis L.			2	
HETEROPTERA				
Aradidae				
Aradus betulae L.			4	+
A. cinnamomeus Panz.			1	
A. pictus Bar.			2	+

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
COLEOPTERA				
Carabidae				
Leistus ferrugineus (L.)	-	+	-	
Notiophilus biguttatus (F.)	-	+	1	
Carabus glabratus Payk.	-	+	-	+
Cicindela sylvatica L.			-	+
Elaphrus cupreus Duft.	-	+	-	
Pterostichus oblongopunctatus (F.)	-	+	-	+
Calathus micropterus (Duft.)			-	+
Dromius agilis (F.)	-	+	3	+
Ptiliidae				
Acrotrichis sp.			1	
Leiodidae				
Anisotoma humeralis (F.)	-	+	9	
A. axillaris Gyll.	-	+	2	+
A. castanea (Herbst)	-	+	4	
A. glabra (Kug.)	-	+	31	
Amphicyllis globus (F.)			24	+
Agathidium rotundatum (Gyll.)	-	+	-	
A. confusum Bris de Barn.	-	+	-	+
A. nigripenne (F.)	-	+	-	+
A.seminulum (L.)	-	+	-	+
A. pisanum Bris. de Barn.	-	+	-	+
Agathidium sp.			12	
Silphidae				
Nicrophorus vespilloides Herbst	-	+	2	
Oiceoptoma thoracica (L.)	-	+	-	
Phosphuga atrata (L.)	-	+	-	
Cholevidae				
Sciodrepoides watsoni (Spence)			1	
Staphylinidae				
Philontus sp.			29	
Creophilus maxillosus (L.)	-	+	-	+
Quedius brevis Erich.			1	
Oxyporus maxillosus F.			1	
Scaphisoma agaricinum L.	-	+	1	
Scaphisoma subalpinum Rtt.	-	+	-	
Lordithon speciosus Erich.			93	
Lordithon lunulatus (L.)			40	
Sphaeritidae				
Sphaerites glabratus (F.)	-	+	1	
Histeridae				
Plegaderus vulneratus (Pz.)	-	+	1	
Myrmetes paykulli Kanaar			1	
Platysoma lineare Erich.	-	+	-	
Scirtidae				
Cyphon sp.			2	
Scarabaeidae				
Aphodius rufipes (L.)			1	
Aphodius lapponum Gyll.	-	+	-	

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
Aphodius piceus Gyll.	-	+	-	
Trichius fasciatus (L.)	-	+	-	+
Lucanidae				
Platycerus caprea (Deg.)	-	+	3	+
Lycidae				
Dictyoptera aurora Hbst.	-	+	6	
Platycis minuta F.			1	
Cantharidae				
Podabrus alpinus (Pk.)	-	+	-	
Rhagonycha atra L.	-	+	1	
Absidia schoenherri (Dejean)	-	+	7	+
Elateridae				
Lacon conspersus (Gyll.)	-	+	-	+
Harminius undulatus (Deg.)	-	+	4	+
Athous subfuscus (Mull.)	-	+	5	+
Limonius aeneoniger (Deg.)	-	+	-	
Denticolis linearis (L.)			6	
Ctenicera pectinicornis (L.)	-	+	-	
C. cuprea (F.)	-	+	-	
Liotrichus affinis (Payk.)	-	+	-	+
Orithales serraticornis (Pk.)	-	+	-	
Prosternon tesselatum (L.)			-	+
Selatosomus impressus (F.)	-	+	1	
S.cruciatus (L.)			1	
S.melancholicus (F.).	-	+	-	
Eanus costalis (Payk.)	-	+	1	+
Ampedus tristis (L.)			5	
A.erythrogonus (Mull.)			2	
A.nigrinus (Herbst.)	-	+	8	+
Sericus brunneus (L.)	-	+	-	
Melanotus castanipes (Payk.)	-	+	8	+
Dalopius marginatus (L.)			-	+
Buprestidae				
Buprestis rustica L.			-	+
* *Melanophila cyanea* (F.)	-	+	-	
** *Antaxia quadripunctata* (L.)	-	+	-	+
Byrrhidae				
Byrrhus fasciatus (Forst.)	-	+	-	
Anobiidae				
Episernus angulicollis Thoms.	-	+	-	
Ernobius explanatus (Man.)	-	+	5	
Anobium rufipes F.			2	
A. thomsoni (Kraatz)			2	+
Hadrobregmus pertinax (L.)	-	+	6	+
Priobium carpini (Hbst.)	-	+	-	
Ptilinus fuscus Geoffr.			-	+
Dorcatoma dresdensis Hbst.			11	+
D. robusta Strand			-	+
Lymexylidae				
Hylecoetus dermestoides (L.)	-	+	8	+

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
H. flabellicornis (Schneider)	-	+	-	
Trogositidae				
Ostoma ferruginea (L.)	-	+	1	+
Peltis grossa (L.)			-	+
Cleridae				
Thanasimus formicarius (L.)	-	+	3	+
T. femoralis (Zett.)	-	+	6	+
Nitidulidae				
Epuraea laeviuscula (Gyll.)	-	+	-	
E. deubeli Rtt.	-	+	-	
E. angustula Sturm.	-	+	-	
E. boreella Zett.)	-	+	-	
E. marseuli Rtt.	-	+	-	
E. pygmaea (Gyll.)			1	
E. biguttata (Thunb.)	-	+	-	
E. variegata (Hbst.)	-	+	-	
E. silacea (Herbst)	-	+	1	+
E. contractula J.Sahlb.	-	+	-	
Ipidia binotata Reitt.			-	+
Pocadius ferrugineus (F.)	-	+	-	
Cychramus variegatus (Herbst)			-	+
C.luteus (F.)			-	+
Glischrochilus hortensis (Geoff.)	-	1		
G. quadripunctatus (L.)		+	5	+
Pityophagus ferrugineus (L.)	-	+	8	+
Sphindidae				
Arpidiphorus orbiculatus (Gyll.)			1	
Rhizophagidae				
Rhizophagus depressus (F.)	-	+	-	
R. ferrugineus (Payk.)	-	+	135	+
R. dispar (Payk.)	-	+	-	
R. nitidulus (F.)			3	+
R. parvulus (Payk)	-	+	1	+
Cucuidae				
Dendrophagus crenatus (Payk.)	-	+	2	+
Pediacus fuscus (Hbst.)	-	+	-	
Cryptophagidae				
Pteryngium crenatum (F.)			1	
Cryptophagus lapponicus Gyll.			1	
Antherophagus pallens (L.)			1	
Erotylidae				
Triplax aenea (Schall.)	-	+	31	+
T. russica (L.)	-	+	136	+
T. scutellaris Charp.	-	+	54	+
Cerylonidae				
Cerylon deplanatum Gyll.	-	+	-	
C. ferrugineum Steph.	-	+	4	+
C. histeroides (F.)			-	+
Endomychidae				
Mycetaea subterranea (F.)	-	+	-	

Species	Paanajärvi Traps	Paanajärvi Hand picking	Kalevala Traps	Kalevala Hand picking
Leiestes seminigra (Gyll.)			-	+
Endomychus coccineus (L.)	-	+	-	+
Coccinellidae				
Coccinella hieroglyphica L.	-	+	-	
Corylophidae				
? Orthoperus punctulatus Rtt.	-	+	-	
Latridiidae				
Latridius hirtus Gyll.	-	+	-	+
L. consimilis Mann.	-	+	-	
L. minutus (L.)	-	+	-	
Latridius sp.			-	+
Enicmus fungicola Thoms.			1	
E. rugosus (Herbst.)	-	+	1	
Corticaria pubescens (Gyll.)	-	+	-	
C. lapponica (Zett.)	-	+	1	
C. ferruginea Marsh.	-	+	-	
Byturidae				
Byturus tomentosus (Deg.)	-	+	-	+
Cisidae				
Cis alter Silfv.			1	
C. jacquemartii Mellie	-	+	2	
C. comptus Gyll.	-	+	1	
C. hispidus (Payk.)			-	+
C. boleti (Scop.)	-	+	-	+
Orthocis alni (Gyll.)			1	
Ropalodontus strandi (Lohse)	-	+	-	
Octotemnus glabriculus (Gyll.)	-	+	-	
Colydiidae				
Lasconotus jelskii (Wank.)	-	+	1	
Mycetophagidae				
Mycetophagus multipunctatus F.			3	
Mycetophagus fulvicollis F..			1	
Oedemeridae				
Calopus serraticornis (L.)			-	+
Oedemera virescens (L.)	-	+	-	
Pythidae			-	
Pytho depressus (L.)	-	+	4	+
* *P. kolwensis* Sahlb.	-	+	-	+
Boridae				
* *Boros schneideri* (Panz.)	-	+	-	+
Salpingidae				
Salpingus ruficollis (L.)			2	
Stenotrachelidae				
Stenotrachelus aeneus Pk.			1	
Tenebrionidae				
Bolitophagus reticulatus (L.)	-	+	12	+
Corticeus fraxini (Kug.)			2	
Mycetochara flavipes (F.)			4	
M. obscura (Zett.)			2	+

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
Anaspidae				
Anaspis marginicollis Lindberg			-	+
A. arctica Zett.	-	+	13	
Tetratomidae				
Tetratoma ancora F.			3	
Melandryidae				
Hallomenus binotatus (Quens.)			1	
Orchesia micans (Panz.)	-	+	14	
O. fasciata (Illiger)			9	
Xylita laevigata (Hell.)	-	+	22	+
Melandrya dubia (Schall.)	-	+	3	+
Cerambycidae				
***Tragosoma depsarium* (L.)			-	+
Arhopalus rusticus (L.)	-	+	-	+
Asemum striatum (L.)	-	+	-	+
Tetropium castaneum (L.)	-	+	13	+
T. fuscum F.			5	
Rhagium mordax (Deg.)	-	+	5	+
R. inquisitor (L.)	-	+	8	+
Oxymirus cursor (L.)	-	+	1	+
Brachyta interrogationis (L.)	-	+	-	+
Gaurotes virginea (L.)			1	
Evodinus borealis (Gyll.)	-	+	-	
Acmaeops septentrionis Thoms.	-	+	3	+
Alosterna tabacicolor Deg.	-	+	1	+
Anoplodera reyi (Heyd.)			-	+
A. virens (L.)	-	+	2	+
Judolia sexmaculata (L.)			1	
Leptura quadrifasciata L.	-	+	-	
* *Necydalis major* L.	-	+	-	
Molorchus minor (L.)	-	+	-	
Callidium coriaceum Payk.			1	
Monochamus sutor (L.)	-	+	-	+
Pogonocherus fasciculatus (Deg.)	-	+	2	+
P. decoratus Fairmaire			1	
* *Acanthocinus aedilis* (L.)	-	+	-	+
Chrysomelidae				
Chrysolina varians (Schall.)			-	+
Curculionidae				
Otiorhynchus nodosus (Mull.)			-	+
Strophosoma capitatum (Deg.)			-	+
Rhyncolus elongatus (Gyll.)	-	+	-	+
R. ater (L.)	-	+	1	+
Hylobius piceus (Deg.)			-	+
H. sibiricus Egorov sp.n. [albosparsus non. Boh., 1845:auct.]	-	+		
H. abietis (L.)	-	+	27	+
H. pinastri (Gyll.)			1	
Pissodes pini (L.)	-	+	13	
P. gylenhalli (Sahlb.)			1	

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
P. harcyniae (Hbst.)	-	+	5	
P. piniphilus (Herbst.)	-	+	7	
Scolytidae				
Hylurgops glabratus (Zett.)	-	+	10	+
H. palliatus (Gyll.)	-	+	33	+
Hylastes brunneus Erich.	-	+	65	+
H. cunicularius Erich.	-	+	92	+
Xylechinus pilosus (Ratz.)	-	+	5	+
Tomicus minor (Hartig)	-	+	6	+
T. piniperda (L.)	-	+	1	+
Dendroctonus micans (Kug.)	-	+	-	+
Phloetribus spinulosus (Rey)	-	+	-	+
Polygraphus subopacus Thoms.	-	+	-	+
P. poligraphus (L.)	-	+	1	+
Scolytus ratzeburgi Janson	-	+	3	+
Pityogenes chalcographus (L.)	-	+	2	+
P. irkutensis Egg.	-	+	-	
P. saalasi Egg.	-	+	-	
P. quadridens (Hartig)	-	+	-	+
P. bidentatus (Herbst)	-	+	-	+
Orthotomicus suturalis (Gyll.)	-	+	-	+
Ips acuminatus (Gyll.)	-	+	-	+
I. sexdentatus (Born.)	-	+	-	+
I. typographus (L.)	-	+	1	+
I. amitinus (Eich.)	-	+	-	
Drycoetes autographus (Ratz.)	-	+	95	+
D. hectographus Reitt.	-	+	-	+
Crypturgus cinereus (Herbst)	-	+	-	+
Trypodendron lineatum (Oliv.)	-	+	41	+
T. signatum (F.)	-	+	32	
Trypophloeus bispinulus Egg.	-	+		
Cryphalus saltuarius Weise	-	+	-	+
Pityophthorus micrographus (L.)	-	+	-	+
P. lichtensteinii (Ratz.)	-	+		
LEPIDOPTERA				
Pieridae				
Pieris napi L.	-	+	-	+
Anthocaris cardamines L.	-	+		
Lycaenidae				
Callophrys rubi L.	-	+		
? Polyommatus semiargus Rot.			-	+
? Lycaeides idas (L.)			-	+
Lasiocampidae				
Lasiocampa quercus L.			-	+
Nymphalidae				
Vanessa atalanta L.	-	+		
Clossiana euphrosyne L.			-	+
Papilionidae				
Papilio machaon L.	-	+	-	+

Species	Paanajärvi Traps	Paanajärvi Hand picking	Kalevala Traps	Kalevala Hand picking
Satyridae				
Erebia ligea L.	-	+		
Erebia embla Thunb.				+
HYMENOPTERA				
Siricidae				
Xeris spectrum L.			1	+
Urocerus gigas L.	-	+		
Xiphydriidae			1	
Xiphydria camelus L.	-	+		
Cimbicidae				
Cimbex femorata L.	-	+	1	
Trichiosoma aenescens Guss.			-	+
Zaraea fasciata L.	-	+		
Pamphilidae				
Cephalcia abietis L.	-	+		
Argidae				
Arge ustulata L.			-	+
Evaniidae				
Brachygaster minuta Ol.			2	
Braconidae				
Wroughtonia dentator L.			1	
Ichneumonidae				
Pimpla aquilonia Cress.	-	+	2	
Dolichomitus terebrans Ratz.			1	
Rhyssa persuasoria L.			4	
Neoxorides montanus Oehlke			3	
Polyblastus varitarsus Grav.			1	
Tryphon sp.				+
Xorides brachylabis Kriechb.	-	+	1	
Odontocolon spinipes Grav.			4	
O. dentipes Gmel.	-	+	2	
Gelis sp.			7	
Echtrus reluctator L.		+		
Aptesis nigrocinctus Grav.			1	
Atractodes sp.				+
Lissonota sp.			2	
Cymodusa sp.				+
Rimphoctona sp.			1	
Ctenopelma sp.	-	+		
Agrypon flaveolatum Grav.		+	1	
Cylloceria borealis Roman	-	+		
C. melancholica (Grav.)	-	+		
Allomacrus arcticus Holmgren	-	+		
Hemiphanes flavipes Foerster	-	+		
Megastylus orbitator Schiodte		+		
Helictes borealis (Holm.)	-	+	17	
Proclitus paganus Haliday	-	+		
P. fulvicornis Foerster	-	+		
Pantisarthrus lubricus Foerst.			1	

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
Symplecis bicingulata Grav.			4	
Gnathochorisis crassula (Thomson)	-	+		
G. dentifer (Thomson)	-		3	
Proeliator proprius Rossem			1	
Aperileptus flavus Foerst.			1	
Plectiscidea erythropyga Grav.		+	1	
Plectiscidea sp.	-	+	5	
Dialipsis exilis Foerster	-	+		
Phthorima sp.			1	
Dryinidae				
Lonchodryinus ruficornis Dalman			2	
Sapygidae				
Sapyga similis L.	-	+		
Formicidae				
Formicoxenus nitidulus Nyl.	-	+		
Camponotus herculeanus (L.)	-	+	6	+
Formica aquilonia Yarrow			776	
F. rufa L.			2	
F. lugubris Zett.			4	
Myrmica laevinodis Nyl.			1	
Vespidae				
Dolichovespula norwegica F.	-	+	1	
Paravespula rufa L.	-	+	1	
P. vulgaris L.			3	
Vespula austriaca Pz.	-	+		
Eumenidae				
Ancistrocerus trifasciatus Müller			-	+
Pompilidae				
Arachnospila sp.	-	+		
Sphecidae				
Pemphredon lugubris F.			14	
Passaloecus insignis V.d.Lind.			1	
Crossocerus ovalis Lep. et Br.				+
Ectemnius continuus F.			1	
Anthophoridae				
Nomada sp.	-	+		
Megachilidae				
?Osmia nigriventris Zett.		+		
Apidae				
Bombus balteatus Dahlbom	-	+		
B. hypnorum L.	-	+		+
B. jonellus (Kirby)	-	+	3	+
B. lapidarius L.	-	+		
B. lapponicus F.	-	+		
B. lucorum L.	-	+		+
B. pascuorum Scop.	-	+	1	+
B. pratorum L.	-	+		+
B. sporadicus Nyl.	-	+		
Psithyrus silvestris Lep.	-	+		

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
DIPTERA				
Cylindrotomidae				
Diogma glabrata (Mg.)	1			
Tipulidae				
Tipula excisa Schumm.	2			
T. excisoides Al.	1			
T. limbata Zett.	1			
T. limitata Schum.			1	
T. subnodicornis Zett.	1			
T. transbaicalica Al.	2		1	
T. variicornis Schum.			1	
T. varipennis Mg.	2			
Phoroctenia vittata Mg.	2			
Limoniidae				
Tricyphona immaculata Mg.	5			
Molophilus ater Mg.	9			
Ula sylvatica (Mg.)			1	
Idioptera fasciata L.			1	
I. pulchella Mg.			1	
Phylidorea fulvonevrosa Schumm.			3	
P. glabricula (Mg.)			1	
P. phaeostigma (Schumm.)			3	
Erioptera lutea Mg.			1	
Dicranomyia modesta Wied.			1	
Limonia tripunctata F.			1	
Metalimnobia bifasciata (Schrank)	1		1	
Discobola annulata L.			2	
D. caesarea O.-S.			2	
Bolitophilidae				
Bolitophila aperta Lundstr.	3			
B. austriaca Mayer	9		5	
B. bimaculata Zett.	1			
B. fumida Edw.	1			
B. ingrica Stack.	16			
B. modesta Lack.	5			
B. nigrolineata Landr.	1		1	
B. obscurior Stack.	1			
B. saundersi (Curt.)	9		8	
Keroplatidae				
Macrocera pumilio Lw.	77		1	
Macrocera stigmoides Edw.			1	
M. vittata Mg.			1	
Isoneuromyia semirufa (Mg.)			1	
Keroplatus sp. (testaceus group)			1	
Diadocidiidae				
Diadocidia ferruginosa (Mg.)			1	
D. spinosula Tollet	1			
D. trispinosa Polevoi			1	
Mycetophilidae				
Mycomya annulata (Mg.)			5	

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
M. bicolor Dz.			I	
M. circumdata Staeg.			II	
M. confusa Väis.			I	
M. festivalis Väis.			5	
M. fimbriata (Mg.)			2	
M. hackmani Väis.	I			
M. humida Väis.			2	
M. karelica Väis.			I	
M. nitida (Zett.)	9		67	
M. pseudoapicalis Landr.			8	
M. pulchella Dz.			3	
M. ruficollis (Zett.)			22	
M. shermani Garr.			39	
M. trilineata Zett.			2	
M. trivittata (Zett.)			3	
M. tumida Winn.	I			
M. vittiventris Zett.			3	
M. wankoviczii Dz			I	
Allocotocera pulchella (Curt.)	I		25	
Anaclileia dziedzickii (Landr.)	I			
Azana anomala (Staeg.)	I		I	
Monoclona braueri (Strobl)			I	
Neuratelia nemoralis (Mg.)	3		I	
Phthinia mira Ostr.	I			
Polylepta borealis Lundstr.	II		87	
P. guttiventris (Zett.)			I	
Sciophila adamsi Edw.	7			
S. balderi Zaitz. et Økl.			I	
S. geniculata Zett.			3	
S. hirta Mg.	2		I	
S. karelica A.Zaitz.			I	
Syntemna daisetsusana Okada			4	
S. hungarica (Lundstr.)			2	
S. relicta (Lundstr.)			I	
Drepanocercus spinistylus Søli			I	
Apolephthisa subincana (Curt.)			I	
Boletina basalis (Mg.)	24		I	
B. borealis Zett.			2	
B. cincticornis Walk.	10			
B. cornuta A.Zaitzev	I			
B. edwardsi Chand.			I	
B. gripha Dz.	I		2220	
B. griphoides Edw.	2		III	
B. jamalensis A.Zaitz.	5		3	
B. moravica Landr.	I			
B. nigricans Dz.			257	
B. nigrofusca Dz.			3	
B. nitiduloides A.Zaitz.	144		I	
B. onegensis Polevoi			I	
B. populina Polevoi	I			

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
B. rejecta Edw.			1	
B. silvatica Dz.			108	
B. triangularis Polevoi	1		24	
B. trivittata (Mg.)	3			
Coelosia silvatica Landr.			1	
C. tenella (Zett.)			1	
C. truncata Lundstr.	1		1	
Ectrepesthoneura bucera Plassm.	1		4	
E. hirta (Winn.)			14	
E. pubescens (Zett.)	2		1	
E. referta Plassm.	3		121	
E. tori Zaitz. et Økl.			1	
Leia subfasciata (Mg.)			4	
Rondaniella dimidiata (Mg.)			1	
Dynatosoma dihaeta Polevoi	8			
D. fuscicorne (Mg.)	2		3	
D. nigromaculatum Lundst.	2			
D. thoracicum (Zett.)	1			
Mycetophila abiecta (Last.)			1	
M. bohemica Last.	5			
M. brevitarsata Lastovka	8		1	
M. confluens Dz.	1			
M. finlandica Edwards			4	
M. fungorum De Geer	6		18	
M. hetschkoi Landr.			3	
M. ichneumonea Say	2		1	
M. ocellus Walk.			1	
M. perpallida Chand.			1	
M. strobli Last.	1			
M. zetterstedti Lundstr.			1	
Phronia biarquata Beck.	7		1	
P. braueri Dz.	1		10	
P. caliginosa Dz.	9		1	
P. cinerascens Winn.	1			
P. crassitarsus Hack.	1		1	
P. disgrega Dz.			1	
P. dubioides Matile			1	
P. dziedzickii Lundstr.	1			
P. elegantula Hack.			1	
P. exigua (Zett.)	1			
P. flavipes Winn.	1			
P. forcipata Winn.	3		28	
P. interstincta Dz.	1		1	
P. nigricornis (Zett.)			2	
P. nigripalpis Lundstr.			28	
P. sylvatica Dz.			1	
P. tiefii Dz.	1			
Platurocypta testata (Edw.)			1	
Sceptonia concolor Winn.			6	
S. costata v.d. Wulp	1			

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
S. fumipes Edw.			3	
S. fuscipalpis Edw.	1		1	
Trichonta atricauda (Zett.)	1		1	
T. facilis Gagné	1			
T. flavicauda Lundstr.	1			
T. amica Gagné	3			
T. subfusca Lundstr.	1			
T. venosa (Staeg.)	1			
T. vitta (Mg.)			1	
Allodia alternans (Zett.)			1	
A. anglofennica Edw.	1			
A. lugens (Wied.)	6		1	
A. pyxidiiformis A.Zaitz.	5			
A. septentrionalis Hack.	7		2	
A. tuomikoskii Hack.	6			
Allodiopsis cristata (Staeg.)	8		11	
A. domestica (Mg.)	1			
A. rustica (Edw.)			1	
Synplasta pseudingeniosa A.Zaitzev	1			
Brachypeza armata Winn.			4	
B. bisignata Winn.			33	
Anatella maritima Ostr.	1			
A. simpatica Dz.	1			
Brevicornu arcticum Lundstr.	2			
B. griseolum (Zett.)			1	
B. griseicolle (Staeg.)	1		1	
B. ruficorne (Mg.)	1			
Cordyla insons Last. et Matile	6			
C. brevicornis Staeg.			1	
C. parvipalpis Edw.	2		3	
C. semiflava Staeg.			1	
C. styliforceps (Bukowski)	1			
Exechia contaminata Winn.	1		3	
E. dizona Edw.	1			
E. dorsalis Staeg.			1	
E. festiva Winn.	1			
E. fusca (Mg.)	1			
E. lundstroemi Landr.			1	
E. parva Lundstr.			1	
E. parvula (Zett.)	1			
E. pseudocincta Strobl			1	
E. repanda Joh.	1			
E. separata Lund.	11		4	
E. spinuligera Lund.	1		1	
E. subfrigida Last. et Matile	-			
Exechiopsis indecisa (Walk.)	2			
Rymosia fraudatrix Dz.	1			
Tarnania tarnanii (Dz.)	4		2	
Synneuridae				
Synneuron annulipes Lund.			1	

Species	Paanajärvi Traps	Paanajärvi Hand picking	Kalevala Traps	Kalevala Hand picking
Pleciidae				
Penthetria funebris Mg.	2			
Bibionidae				
Dilophus femoratus Mg.			17	
Bibio nigriventris Hal.			15	
Rhagionidae				
Rhagio scolopaceus L.	1		1	
Symphoromyia crassicornis Panz.	1			
Xylophagidae				
Xylophagus cinctus De Geer	1			
X. compeditus Wied.	1			
X. matsumurae Myiat.			2	
Stratiomyiidae				
Sargus rufipes Wahlberg			4	
Beris chalybata Forster	2			
Asilidae				
Lasiopogon cinctus F.			1	
Choerades gilva L.	1			
Empididae				
Tachypeza fennica Tuomik.			2	
T. heeri (Zett.)			3	
T. nubila (Mg.)			20	
T. winthemi Zett.			1	
T. truncorum Fll.			5	
Platypalpus boreoalpinus Frey			8	
P. confinis Zett.			9	
P. ciliaris (Fall.)	1			
P. ecalceatus (Zett.)	1		5	
P. nigritarsis Fall.			1	
? P. pallidiventris Mg.			1	
P. pseudorapidus Kovalev	1			
P. stigmatellus Zett.	1		6	
Symballophthalmus dissimilis (Fall.)			1	
Hybos grossipes (L.)			5	
Bicellaria nigra (Mg.)	1		7	
B. subpilosa Collin	3		2	
B. sulcata Zett.	1		1	
Leptopeza borealis Zett.			1	
Euthyneura albipennis Zett.			1	
E. myrtilli Macq.			3	
Rhamphomyia anomalina Zett.	3		40	
R. angulifera Frey			1	
R. curvula Frey			1	
R. dispar Zett.	2			
R. sulcatina Collin			1	
R. unguiculata Frey			1	
Empis borealis L.	1			
E. lucida Zett.	3			
Heleodromia immaculata Hal.			2	

Species	Paanajärvi		Kalevala	
	Traps	Hand picking	Traps	Hand picking
Dolichopodidae				
Dolichopus annulipes Zett.			10	
D. armillatus Wahlb.			1	
D. campestris Mg.			1	
D. cruralis Wahlb.			1	
D. longicornis Stann.			1	
D. longitarsis Mg.			1	
D. nigricornis Mg.			23	
D. simplex Mg.			2	
Hercostomus cupreus Fall.			1	
Porphyrops elegantula Mg.			1	
Lonchopteridae				
Lonchoptera fallax de Meijere			1	
Platypezidae				
Calomyia dives Zett.			6	
C. elegans Mg.			1	
C. speciosa Mg.			1	
Syrphidae				
Platycheirus manicatus Mg.			1	
Melanostoma mellinum (L.)	9		2	
Leucozona lucorum (L.)			1	
Sphaerophoria menthastri (L.)	1		5	
S. sarmatica Bankowska			1	
Chrysotoxum arquatum (L.)			1	
? Neoascia aenea Mg.	1		1	
Neoascia podagrica F.			2	
Sphegina sibirica Stack.	3		1	
Pipiza lugubris F.			1	
P. quadrimaculata Panz.	4		1	
Neocnemodon vitripennis Mg.	2			
Cheilosia albitarsis Mg.			1	
C. angustigenis Beck.	1			
? C. chloris Mg.	1			
C. ingrica Stack.			1	
? C. longula Zett.	1			
C. pagana Mg.	2			
C. rotundicornis Hellén	1			
Volucella bombylans L.	1		1	
Sericomyia lappona (L.)			3	
Helophilus pendulus (L.)	2			
Xylota femorata L.	1			
Sphecomyia vespiformis Gorski	3			
Micropezidae				
Compsobata cibaria (L.)			1	
C. commutata Czerny	1		1	
Neria nigricornis (Zett.)			1	
Psilidae				
Chamaepsila humeralis (Zett.)			1	
? C. nigra (Fall.)			2	
? Psila atra (Mg.)	1		1	

Species	Paanajärvi Traps	Paanajärvi Hand picking	Kalevala Traps	Kalevala Hand picking
P. merdaria Collin	1			
Psilosoma lefebvrei Zett.			2	
Loxocera ichneumonea L.			1	
Tephritidae				
Chaetostomella cylindrica R.-D.			2	
? Campiglossa borealis Portsch.			3	
Dryomyzidae				
Dryomyza flaveola (F.)	3		4	
Sepsidae				
? Meroplius stercorarius R.-D.	1			
Nemopoda nitidula Fall.			1	
Sepsis cynipsea (L.)			1	
S. flavimana Mg.			1	
S. orthocnemis Frey			1	
Sciomyzidae				
Pherbellia dubia Fall.	1			
Ectinocera borealis Zett.	1			
Renocera pallida Fall.			1	
Tetanocera elata F.			1	
Trypetoptera punctulata Scopoli			1	
Lauxaniidae				
Homoneura lamellata Beck.	1			
Luciella affinis Zett.			1	
L. illota Lw.			4	
? L. laeta Zett.			9	
Sapromyza hyalinata (Mg.)			1	
Lauxania cylindricornis F.	4			
Calliopum aeneum Fall.			1	
Piophilidae				
Piophila foveolata Mg.	1			
? P. varipes Mg.	1			
Mycetaulus bipunctatus Fll.			1	
Amphipogon flavum Zett.			3	
Clusiidae				
Clusiodes freyi Tuomikoski			1	
C. geomyzinus (Fall.)	2			
C. ruficollis (Mg.)			1	
Pallopteridae				
Palloptera venusta			1	
Acarthophthalmidae				
Acartophthalmus nigrinus (Zett.)			6	
Heleomyzidae				
Borboropsis puberula (Zett.)			1	
Morpholeria obscuriventris Zett.	1			
Suillia apicalis (Lw.)	2			
S. atricornis (Mg.)	1		4	
S. bicolor (Zett.)			3	
S. fuscicornis (Zett.)			1	
S. mikii (Pokorny)	1		4	

Species	Paanajärvi Traps	Paanajärvi Hand picking	Kalevala Traps	Kalevala Hand picking
Opomyzidae				
Anomalochaeta guttipennis (Zett.)	2			
Pseudopomyzidae				
Pseudopomyza atrimana Mg.			7	
Asteiidae				
Leiomyza scatophagina (Fall.)			1	
Milichidae				
Neophyllomyza acyglossa Villeneuve			1	
Ephydridae				
Scatella stagnalis Fall.			1	
Diastatidae				
Diastata vagans Lw.			1	
Drosophilidae				
Drosophila transversa Fall.	30		4	
Chloropidae				
Elachiptera cornuta (Fall.)	1			
Chlorops meigeni Lw.			1	
C. speciosus Mg.	2			
Thaumatomyia trifasciata Zett.	1		5	
Scatophagidae				
Delina nigrita (Fall.)			1	
D. sellatum Hack.			2	
Cordilura albipes (Fall.)			16	
Megaphthalma pallida (Fall.)			3	
? Orthochaeta pilosa Zett.			1	
Scatophaga furcata (Say)			1	
? S. pictipennis Old.			1	
S. suilla (F.)			9	
? Cosmetopus fulvipes Zett.			1	
? Trichopalpus punctipes Mg.			1	
Pogonota barbata (Zett.)			3	
Muscidae				
Alloeostylus diaphanus (Wied.)			1	
Hydrotaea pandellei Stein			1	
Mesembrina resplendens Wahlb.			2	
Caliphoridae				
Calliphora loewi End.			1	
Protophormia terraenovae (R.-D.)			1	
Sarcophagidae			1	
Parasarcophaga caerulescens (Zett.)	1			

The Geology of The proposed Kalevala, Tuulijärvi, Koitajoki and Tolvajärvi national parks

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Introduction

The Institute of Geology of the Karelian Research Centre, Russian Academy of Sciences, conducted a series of geological and geomorphological studies in the territories of the proposed Kalevala, Tuulijärvi, Koitajoki and Tolvajärvi national parks situated close to the state border between the Republic of Karelia and Finland.

The geological structure of both Pre–Quaternary and Quaternary deposits within these areas was studied. The data obtained may be used to determine the position of the study areas in relation to the overall Quaternary cover structure of Karelia. We also sought geological sites of scientific, educational, aesthetic and recreational value. The diversity of flora and fauna is related to that of geological and geomorphological landscapes and soils, and are thus affected by the presence of crystalline rock from the oldest Precambrian complexes. Geological sketch maps were drawn in order to assess the value of delineating the proposed protected areas on the basis of those geological criteria which influence biodiversity.

Methods

Satellite and geophysical (gravimetric and magnetic) maps were decoded in order to determine the regional position of the study areas in relation to the Precambrian geological structures known to exist in the Republic of Karelia and Finland. Field excursions were made in order to verify the results of satellite image decoding.

Geological transects were made, along which natural bedrock exposures, and man–made outcrops were studied. The mineral composition of rocks was analysed in the field. Links between rock varieties were traced, the relative age sequence of the rocks was determined and rock samples were collected. A tectonic study of the structure of the areas in question was conducted on the basis of structural rock observations.

Representative rocks and minerals were analysed petrographically, chemically and spectrally.

The results were used to prepare geological sketch maps of scales 1:100 000 and 1:200 000.

Acknowledgements

Financial support for the study was provided by the Regional Environment Centre of Northern Ostrobothnia through the European Union LIFE project 'Protection of old–growth forests in the Kuusamo area'. We are grateful to Dr. Raimo Heikkilä, Director of the Friendship Park Research Centre, Kainuu Environment Centre, for his assistance in conducting field studies within the Finnish territories adjoining the national parks in question. The authors are indebted to I. N. Demidov (Laboratory of Quaternary Geology and Palaeo–ecology), V. S. Plaksin (Laboratory of Metallogeny) and K. G. Gorlova (Technological Mineralogy and Stone Processing Team), all of whom participated in the field work.

Results and discussion

General geological structure of the proposed national parks

From a geological point of view all the proposed national parks (PNP) belong to the West Karelian structural–formational zone. This differs from other Precambrian zones occurring in Karelia in terms of its geological and tectonic evolution, the primary composition of its constituent complexes and metallogenic specialisation. The zone covers a large part of western and southern Karelia. Available geophysical data reveals a thickening of the Earth's crust within the zone to 42–45 km, as well as regional magnetic field values which are higher than average. All known iron deposits in Karelia, such as those at Kostamus, Korpanki, Himola, Mezhozerskoye and Voloma, are located within the West Karelian zone.

Archean and Proterozoic granitoid and supracrustal (volcano–sedimentary) complexes predominate near to the Finnish–Russian state border. The crystalline rocks of Early Precambrian complexes occur in three structural layers: 1) Early Archean gneiss and gneiss-granitoid complexes; 2) Late Archean volcano–sedimentary crystalline rocks and granitoid complexes; and 3) Early Proterozoic supracrustal units. Late Archean supracrustal complexes, the rocks of the so–called Archean greenstone belts, are scarce, as too are Proterozoic rocks. According to some authors (Kratz 1963, Geology of Karelia 1987), the Early Archean (Saamian) gneiss and granite–gneiss complexes (granulite complex) are the oldest and deepest. They have been most profoundly affected by granite formation and migmatization, and form a basement upon which Lopian volcano–sedimentary rocks lie.

Relics of Early Archean units occur close to Lake Ylä–Kuittijärvi (Kalevala PNP, Vuokkiniemi Block) and Lake Tuulijärvi (Tuulijärvi PNP, Tuulijärvi Block). Early Archean units are formed in these blocks by amphibole–bearing gneisses, amphibolites, enderbites, biotite and hypersthene–biotite plagiogneisses, bipyroxene schists, hornblendites and less common ultramafic rocks. Aluminous rocks such as garnet–biotite, bimica and garnet–sillimanite–muscovite–biotite gneisses characteristically occur among gneisses and amphibolites (Lazarev 1971, Sviridenko 1980). The rocks are metamorphosed to granulite, amphibolite and epidote–amphibolite grade, and migmatized by various granites.

All these rocks occur as non–equidimensional remnants and relics in migmatite, granite and gneissose–granite fields. The primary nature and sequence of formation of the gneisses are not known because their original genetic characteristics have been lost. Early Archean diorite–gneisses cut by plagiogranite–gneiss, tonalite–gneiss, charnockite as well as plagiomicrocline and microcline granite bodies are present as numerous remnants in migmatite fields.

The second structural level is formed by Late Archean (Lopian) supracrustal units, which persist as small remnants and xenoliths in Tolvajärvi and Koitajoki PNPs, together with widespread granitoid and migmatite complexes. Isotopic dating reveals the upper age boundary of these units to be over 2 700 Ma (Bibikova et al. 1977). The third structural layer is composed of Lower Proterozoic Jatulian sandstones. These are very rare and have only been found at Tolvajärvi PNP. Throughout all the PNPs Early Precambrian complexes are cut by Archean and Proterozoic gabbro–dolerite and dolerite bodies.

Kalevala National Park

Geological characteristics of the area

The Kalevala PNP lies in the eastern part of the geological structure known as the Vuokkiniemi Block. It is remarkable for the occurrence of Archean (pre 3.15 Ga) supracrustal complexes formed by amphibole– and biotite–bearing gneisses and infracrustal complexes composed of granitoids, tonalite gneisses, gneissose granodiorites and charnockites. Geological and geophysical data show that structurally speaking the Vuokkiniemi Block comprises a fairly isometric rounded scarp in the Lower Archean crystalline basement, rimmed by a belt of Early and Late Archean fault zones. These acted as pathways for the upward flow of magma, which provided the material for Lopian volcano–sedimentary complexes.

The Lower Archean strata comprise groups of widespread, highly metamorphosed supracrustal rocks such as biotite, garnet–biotite and amphibole–biotite gneisses, and amphibole–bearing gneisses (amphibole–biotite–quartz–plagioclase gneisses, garnet–amphibole–quartz–plagioclase gneisses and biotite–amphibole gneisses). Much of the area studied is made up of infracrustal complexes consisting of the oldest gneissose granodiorites, tonalite gneisses, plagiogneissose granites, granodiorites, plagiomicrocline and microcline granites, amphibole–microcline granites and charnockites. The youngest strata are represented by dolerite and gabbro–dolerite dykes. Several local zones with abnormally high magnetic field values caused by the occurrence of minor magmatic intrusions (gabbro–peridotite formations) have been reported from the south–eastern part of the Kalevala PNP. One typical example is the Sokhroma intrusion. The presence in this intrusion of titanomagnetite (up to 15 %) is characteristic. This is a low grade, fine to medium grained, disseminated type of ore. Archean crystalline rocks have a long structural evolution and have been deformed repeatedly by folding.

The geological sketch map of the Kalevala PNP (Fig. 1) shows that north-easterly orientated structures dominate in the eastern part. Structures running along an east–west axis prevail in the central, western and north–western parts. This general structure is the result of a number of concurrent, non–equidimensional deformation phases. A Z–shaped synform is clearly to be seen within the study area. It comprises a sagged fold situated in the centre of the Kalevala PNP. Its axial plane is orientated approximately east–west and is curved in an undulating fashion. The northern flank of this steep Z–shaped fold strikes at 330° (north–westerly) while its southern flank (fragment) approaches at 285° (west–northwesterly). The flanks of the fold are topographically apparent as hills with numerous flattened scarps of crystalline rock making up the denudation relief characteristic of the area. Additional geological evidence, especially from the western part of the PNP, is required in order to arrive at comprehensive geological map of the entire study area.

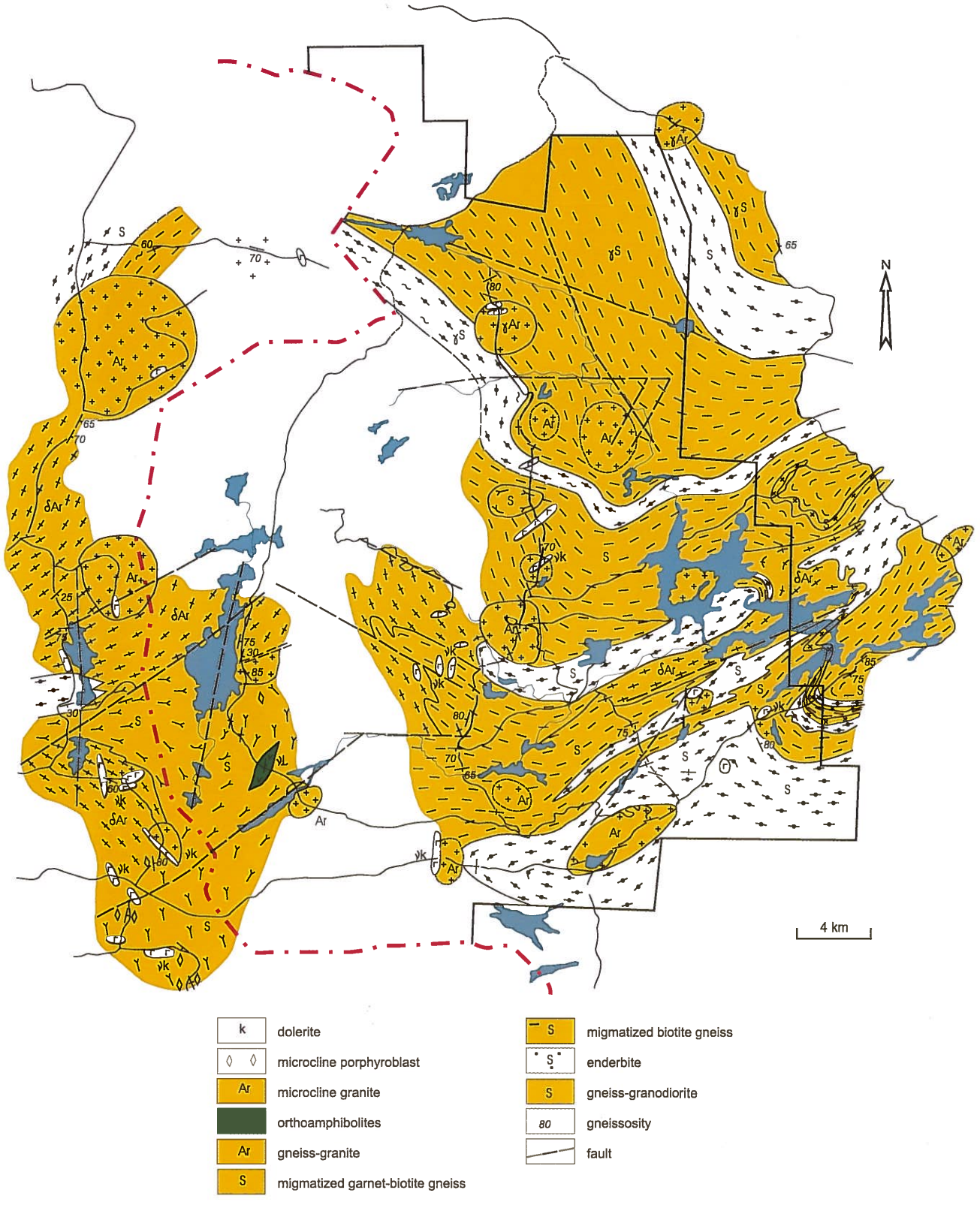


Fig. 1. Geological map of the proposed Kalevala National Park and adjacent Finnish territories.

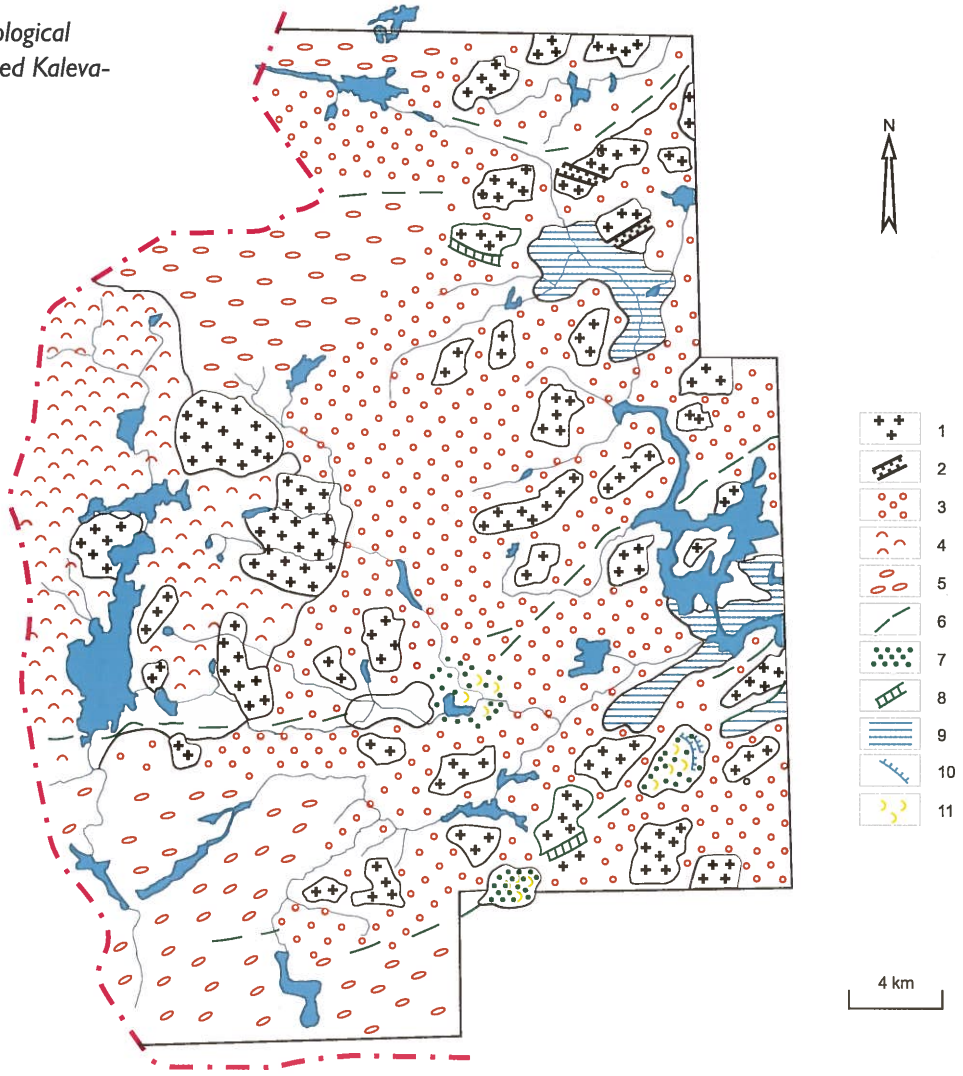
Geomorphological characteristics of the area

Three topographic layers may be distinguished within the Kalevala PNP. They differ in terms of the altitudes of peaks of higher ground situated in the interfluves, the vertical ruggedness of the relief, the morphology of watersheds, river valleys and drift lake basins, the predominance of loose sediments and the forms of accumulation relief produced by these. The upper layer forms an amphitheatre which rims the territory to the north, west and south. In areas of higher ground, i.e. the locations of watersheds, the absolute altitudes of peaks vary from 211 to 264 metres above sea level, with local differences in relief of 28 to 33 metres. Denudation–tectonic bedrock relief featuring a well–defined block pattern occurs in the northern and southern parts of the amphitheatre (Fig. 2.). As a result, both raised and hollow landforms are rectilinear in plan view. Steep slopes and ledges are common. The orientation of the landforms corresponds to the direction of the faults and crevices. The Quaternary strata are 2 to 4 metres thick, but in the western part of the amphitheatre there is a dense massif formed of hilly moraines that lie on the bedrock.

Fig. 2. Typical bedrock relief in the proposed Kalevala National Park.

The entire central part of the area is made up by the middle layer, represented by an outwash plain which somewhat levels the irregular surface of the underlying crystalline rock. The absolute altitudes of the peaks in this layer lie between 150 and 180 metres, with local differences in relief of less than 18 to 20 metres. The outwash plain reveals a general ridged pattern. This middle layer is less rugged than the upper layer and moraines, i.e. locally drumlinised plains, are more commonly encountered. The absolute altitudes of watersheds in the lower layer vary from between 140 and 160 metres. Glaciolacustrine and lacustrine plains have formed in depressions. Accumulation relief and Quaternary deposits were formed during the melting of the last Scandinavian ice sheet during the Salpausselkä II stage (10,6 – 10,2 thousand years ago) and then further modified during late and post–glacial periods. The distribution, composition and density of the various types of Quaternary strata depend on the topography and composition of crystalline rocks and on certain characteristics of the sedimentation process occurring during the degradation of the last ice sheet (Fig. 3).

Fig. 3. Geomorphological map of the proposed Kalevala National Park.



1-2. denudation-tectonic relief: massifs and ridges composed of crystalline rocks and overlain locally by a discontinuous 1,0 - 1,5 m thick till cover; 2. near-fault cracks. 3-5. glacial relief: 3. ridged outwash plain; 4. accumulative hilly angular morainal massif; 5. drumlins. 6-8. glaciofluvial relief: 6. esker ridges; 7. glaciofluvial deltas; 8. rills of post-glacial discharge. 9. glacial plains. 10. terraces of periglacial water bodies. 11. aeolian relief-dunes

The thickness of the Quaternary strata varies from tens of centimetres in the vicinity of bedrock scarps to 20–30 metres in deep crystalline basement depressions and in zones formed of large accumulative glacial and aqueoglacial units. The petrographic and mineral composition of the till reflects fairly well the composition of the underlying bedrock. Boulder–pebble fractions are dominated by granitoid rock fragments, mafic rock clasts being less abundant. Sand fractions are dominated by quartz, feldspar, biotite, and amphibole. The average chemical composition of moraines in West Karelia also indicates the dominant role played by various granitoids on moraine formation: 73 % SiO_2, 12 % Al_2O_3, 3 % Fe_2O_3, 3 % CaO, and 1 % MgO.

Basal moraines constitute gently sloping, locally drumlinised plains that discontinuously lie on Precambrian rocks over most of the territory studied. The till layer is at least 10 metres thick in the drumlins but seldom more than 3 metres thick in the depressions between them. Drumlinised moraine plains were formed as the piedmont lobe moved from the south–west to the north–east towards the Kuittijärvi lake basin. North of Lake Lapukkajärvi is a large angular massif formed of hilly moraines at the boundary of two non–equidimensional ice flows. There the relief comprises a mosaic pattern of low rounded moraine hills and paludified depressions in between. The 10–20 metre thick till cover completely levels out all bedrock relief.

The distribution pattern of glaciofluvial deposits is irregular. These deposits are made up of non–equigranular, well washed and graded sand, gravel and shingle. They occur in three big glacial melt–water discharge systems that consist of esker ridges, deltas and rills of post–glacial discharge. One system extends 30 km from Lake Latvajärvi north–eastwards via Lake Sokhroma as far as Lake Keynäsjärvi. Another system stretches for 35 km in the same direction from the southern end of Lake Lapukkajärvi via Lake Kaunisjärvi to Lake Venehjärvi. The third one runs approximately east to west across the northern part of the Kalevala PNP. The esker ridges are 15–20 metres high and several kilometres long. The largest deltas (Lake Kaunisjärvi, Lake Sokhroma and the area south of Lake Piirtojärvi) cover an area of 2,0–2,5 km^2. The glaciofluvial deposits here are over 20 metres thick. They differ slightly in mineral and petrographic composition from the moraines which produced them through a process of scouring. Kettle holes, dunes and lake and river terraces are often formed on the surface of glaciofluvial deltas.

Limnoglacial deposits consist of fine sand, silt and varved clay. Various lithological types of these sediments were formed on the bed of periglacial Lake Kuittijärvi, which stood at a level of 120–130 metres above sea level. Sediments also formed in smaller localised bodies of periglacial water, their depth permitting. Varved clay from periglacial Lake Kuittijärvi is encountered along the shores of lakes Marjaselkä and Keynäsjärvi. Varved clay was also found 3 km north–west of Lake Sokhroma in a creek valley 125 metres above sea level. In the vicinity of Venehjärvi village sand forms a limnoglacial plain. Silt and sand from shallower bodies of periglacial water occurs to the north of Venehjärvi near Lake Venelampi, and is also common in the vicinity of lakes Kaunisjärvi and Lapukkajärvi. These water bodies were formed during the late Pleistocene epoch and persisted into the early Holocene.

Holocene deposits are represented by biogenic peat and sapropel, aeolian sand, as well as alluvial and lake sediments. Peat deposits and hilly morainal provinces are common, the former being particularly widespread towards the north-east of the territory. Well–graded aeolian sand forms small dunes on the surface of glaciofluvial deltas near lakes Sokhroma, Kaunisjärvi and Piirtojärvi.

Because the river network is young and the till contains an abundance of boulders, alluvial deposits are predominantly composed of thin channel–facies of round stones and pebbles. A low–lying flood plain and a first terrace above the plain consisting of sand–silt sediments are to be found in the river valleys (Fig. 4).

Glacial sediments (basal moraine) are the most commonly encountered sediments in the area. These occur in the form of a till dominated by coarse sand, loamy sand being less common. Boulder–pebble–gravel fractions account for 50–70 % with sand fractions making up 30–40 %.

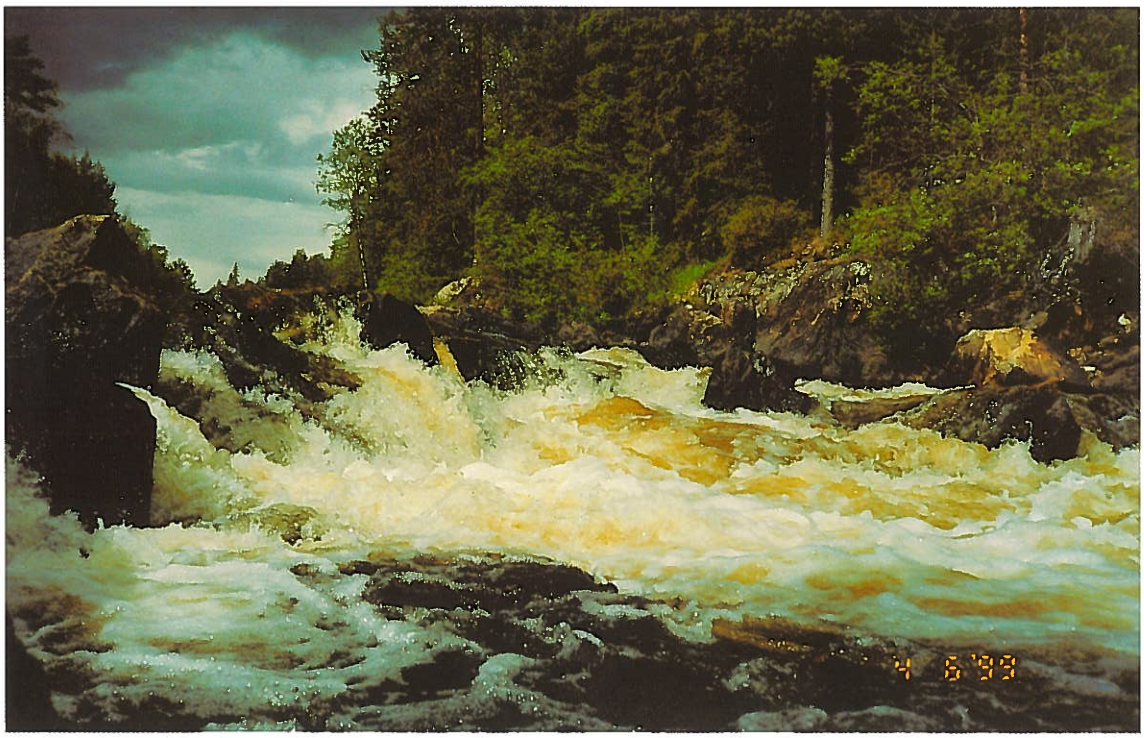


Fig. 4. Kulmakoski rapids in the river Vuonnisjoki in the proposed Kalevala National Park.

Geological characteristics of Tuulijärvi PNP

The Tuulijärvi PNP lies in the eastern part of the geological structure known as the Tuulijärvi Block. Here examples of the Earth's oldest Lower Archean and Late Proterozoic rocks, aged around 3,15 Ga (Fig. 5), are exposed. Structurally speaking, the Lower Archean basement blocks, which consist of rocks metamorphosed to granulite grade, are rimmed by Late Archean rocks without any visible non-contiguity.

The area is dominated by Late and Lower Archean supracrustal rocks. Compositionally and genetically differing infracomplexes formed from granitoids, gneissose–granodiorites and charnockites are scarce.

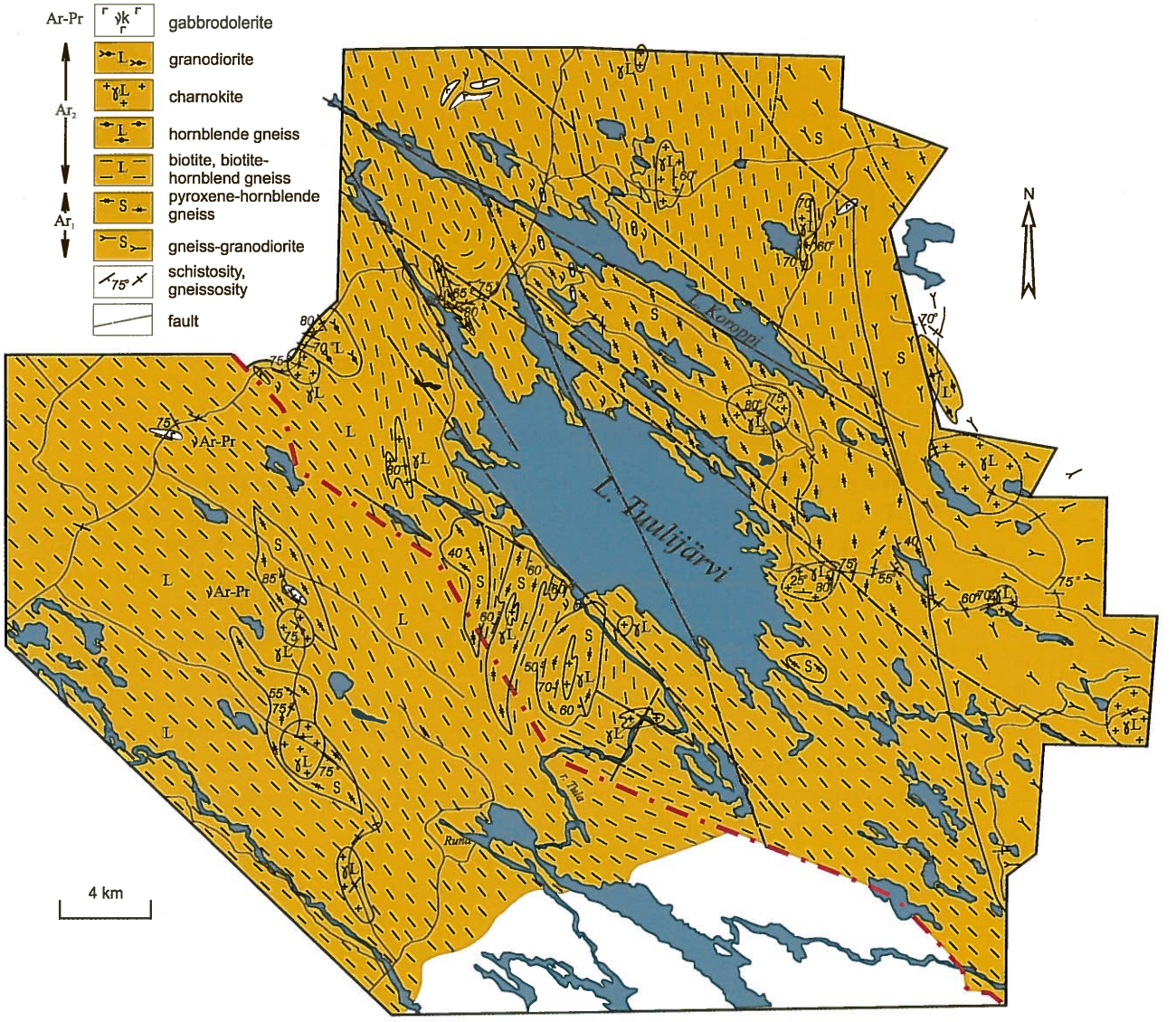


Fig. 5. Geological map of the proposed Tuulijärvi National Park.

The most common rocks in the Precambrian complexes are gneissose–granodiorites, pyroxene–amphibole and biotite–amphibole gneisses, amphibole–microcline and microcline–plagioclase granites, granodiorites, and gabbro–dolerites. Lower Archean units that occur as blocks among gneisses and gneissose–granites incorporate a heterogeneous rock complex composed of granulites, enderbites, and gneissose–granodiorites metamorphosed under conditions of high temperature and pressure (T = 740–800° C, P = 7–8 kbar). Granulites occur as rocks of predominantly intermediate composition, whereas enderbites comprise hypersthene and bipyroxene schists. The mineral composition of these includes plagioclase (labrador–bitownite), hypersthene, diopside, quartz, ore minerals (ilmenite, magnetite) and hornblende. Rocks metamorphosed to granulite grade have endured diaphthoresis and are thus altered to enderbites. Basic granulites consist of dipside, hypersthene, plagioclase and amphibole.

Characteristic of the geological structure of the Tuulijärvi PNP is the general occurrence of north–westerly orientated structures and the coincident existence of late tectonic dislocations. Such dislocations are responsible for the outlines of Lake Tuulijärvi, the main water body within the proposed park, and Lake Koroppijärvi. Deformation led to linear folds that run predominantly in a north–westerly direction, gently dropping also to the north–west. The earliest folding (S1) in this area is indicated by the position of crystalline rock and the presence of earlier, roughly north–south orientated, lineation. Later folding (S2) is observed in granite–gneisses, where lineation is orientated towards the north–west. The most recent tectonic movements are responsible for brittle deformation and occur as strike–slip fault zones that are predominantly aligned towards the north–west. To date no ore occurrences or deposits have been discovered in the area.

Geological structure of Koitajoki PNP

The occurrence of monorock complexes composed of the oldest Archean gneissose–granodiorites and subsequently formed migmatite–plagiomicroclime granites is structurally characteristic of the area (Fig. 6). Exposures of migmatite–plagiomicrocline granites formed after Archaean biotite and amphibole gneisses (which themselves occur as remnants of supracrustal units) are encountered among dominant gneissose–granodiorites and subsequently formed migmatites.

Biotite gneisses and subsequently formed migmatites consist of grey, medium–grained, banded, occasionally thinly–laminated, highly migmatised cataclastic rocks. In the northern, eastern and southern parts of the Koitajoki PNP plagiomicrocline and microcline granites form small independent massifs. Granites more commonly form migmatites which post–date gneissose–granodiorites, biotite gneisses and amphibole gneisses.

Archean rocks are represented by Late Archean amphibolized gabbro–dolerite dyke bodies chiefly restricted to the central part of the area. Lopian gabbro–dolerite dyke bodies strike at 335–340° (north–westerly) and dip vertically. Proterozoic massive, unfoliated dolerite bodies that predominantly run in an approximately north–south direction make up the most recent units in the Koitajoki PNP.

Structurally speaking, Koitajoki PNP is made up of a monorock complex consisting of the oldest gneissose–granodiorites. Its metamorphic banding and early relict gneissosity run in a north–northeast direction. Throughout the area the rocks are profoundly cut by tectonic dislocations orientated towards the north–east, north–west and from north to south. These are common in zones formed of migmatite plagiomicrocline and microcline granites post–dating gneissose–granodiorites. The low, paludified parts of the relief are restricted to this area.

In the centre of the western part of the Koitajoki PNP there is an oval gneissose–granodiorite massif which has been neither dislocated by tectonic movements nor migmatised by Lopian granites. The massif is bounded by the gentle oval of the River Koitajoki to the south and east, by the Lake Kangasjärvi system to the north and by the convex outline of Lake Sysmäjärvi to the west in Finland. The gneissose–granodiorite massif is some 23 km in diameter.

A system of amphibolized gabbro–dolerite dykes striking at 335° (NW) lies in this intact gneissose–granodiorite massif. This shows that early Lopian brittle deformations occurred in the area which was later affected by vigorous tectonic movements.

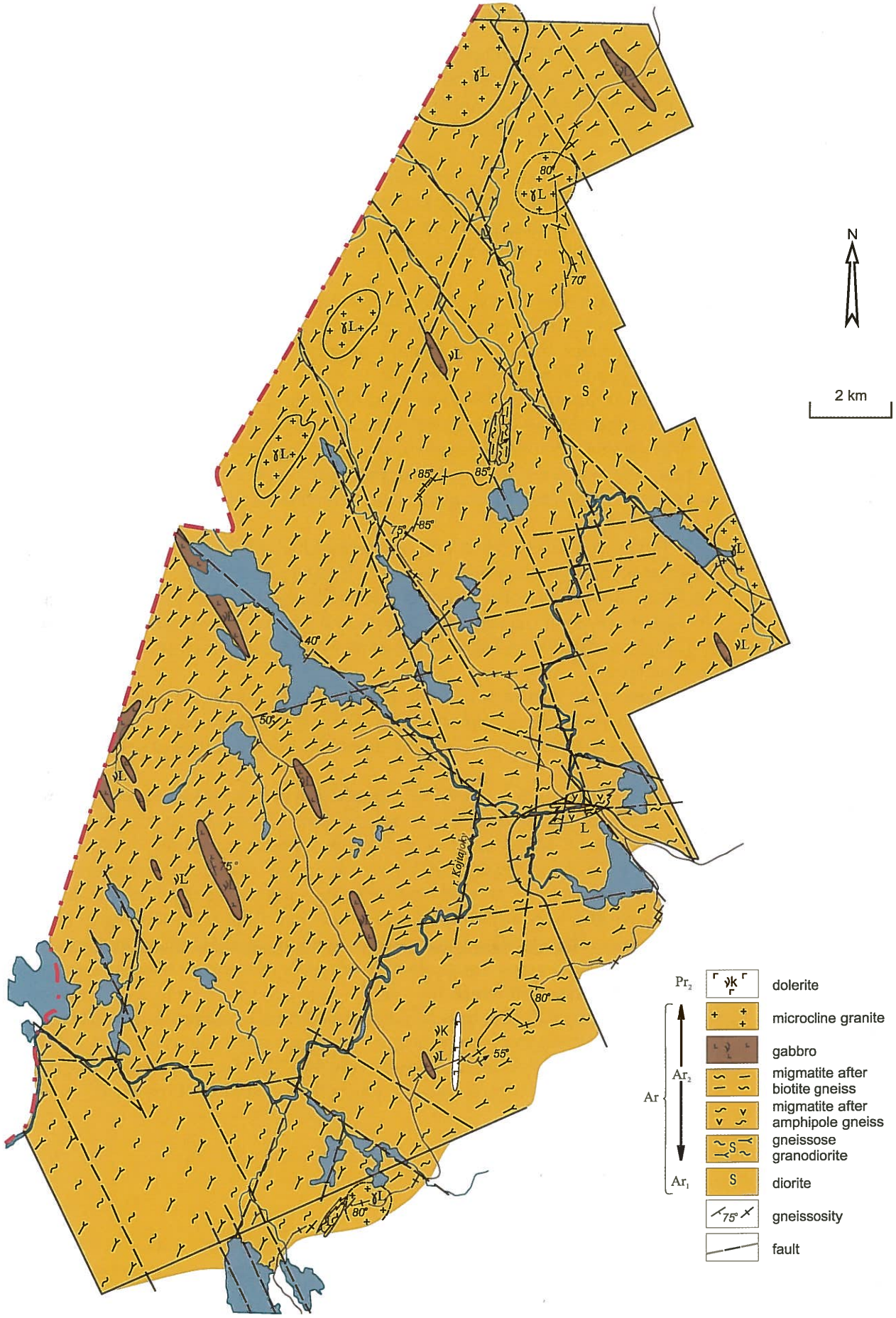


Fig. 6. Geological map of the Koitajoki proposed National Park.

Geology of the planned Tolvajärvi Landscape Reserve

In the Tolvajärvi PNP Archean crystalline rock overlain by Quaternary strata prevails while Proterozoic crystalline rocks are scarce (Fig. 7). Analysis of graviometric and magnetometric data available for the area reveals a uniform background without any peaks, suggesting the absence of large zones formed of Lopian supracrustal rocks.

The groups of Archean crystalline rocks occurring in the Tolvajärvi PNP include biotite gneisses, plagiomicrocline and microcline granites, migmatites of these granites formed subsequently to biotite gneisses, gabbro–amphibolites and gabbro–dolerites. Proterozoic rocks are represented by gabbro–dolerites and metasandstones.

Biotite gneisses are the oldest rocks in the Tolvajärvi PNP. These are medium grained, banded rocks that display granoblastic and nematogranoblastic structures. The gneisses consist of unequally migmatised substrate (biotite gneiss), the metatect (granite) ratio being variable.

Late Archaean granites cover most of the area. They are represented by plagiomicrocline and microcline granites, microcline porphyroblastic granites and migmatites of these granites formed subsequent to supracrustal biotite gneisses. The supracrustal units are unequally migmatised. These include shadow migmatites with large quantities of metatect (granite), restites of substrate occasionally being encountered.

Proterozoic supracrustal units are represented by Jatulian quartzitic sandstones that occur on the south shore of Lake Julajärvi. This forms a small–scale syncline which lies on a Lopian gneissose-granite basement. The quartzitic sandstones consist of very light coloured, medium to fine grained, thinly laminated and schistose metasandstones and silts. These units vary in thickness from a few metres up to ten metres.

Proterozoic intrusive rocks are represented by gabbro–dolerites that are, generally speaking, uncommon in the Tolvajärvi PNP. Gabbro–dolerite dykes extend in north–westerly and north–easterly directions over distances of several hundred metres.

Structurally the Tolvajärvi PNP is located in an area of vigorous Late Archean granitoid evolution. Relics and remnants of Late Archean Lopian supracrustal rocks are encountered. North–easterly and north–westerly orientated brittle deformations are widespread throughout the tectonic zones. Late tectonic movements resulted in a cataclasis of granites and migmatite–granites. Early Proterozoic movements gave rise to gently dipping structures that differ from those generated in Archean time. Slightly folded and weakly metamorphosed Jatulian sandstones that constitute gently dipping trough–like structures lie on strongly reworked and dislocated Archean crystalline rock.

The Tolvajärvi PNP is thus an area formed from a monorock granitic complex with high percentages of silica (SiO_2 >70 %) and potassium (5–7 % K_2O) while percentages of other elements are relatively low. This factor is responsible for the high soil acidity which consequently affects the vegetation of the area.

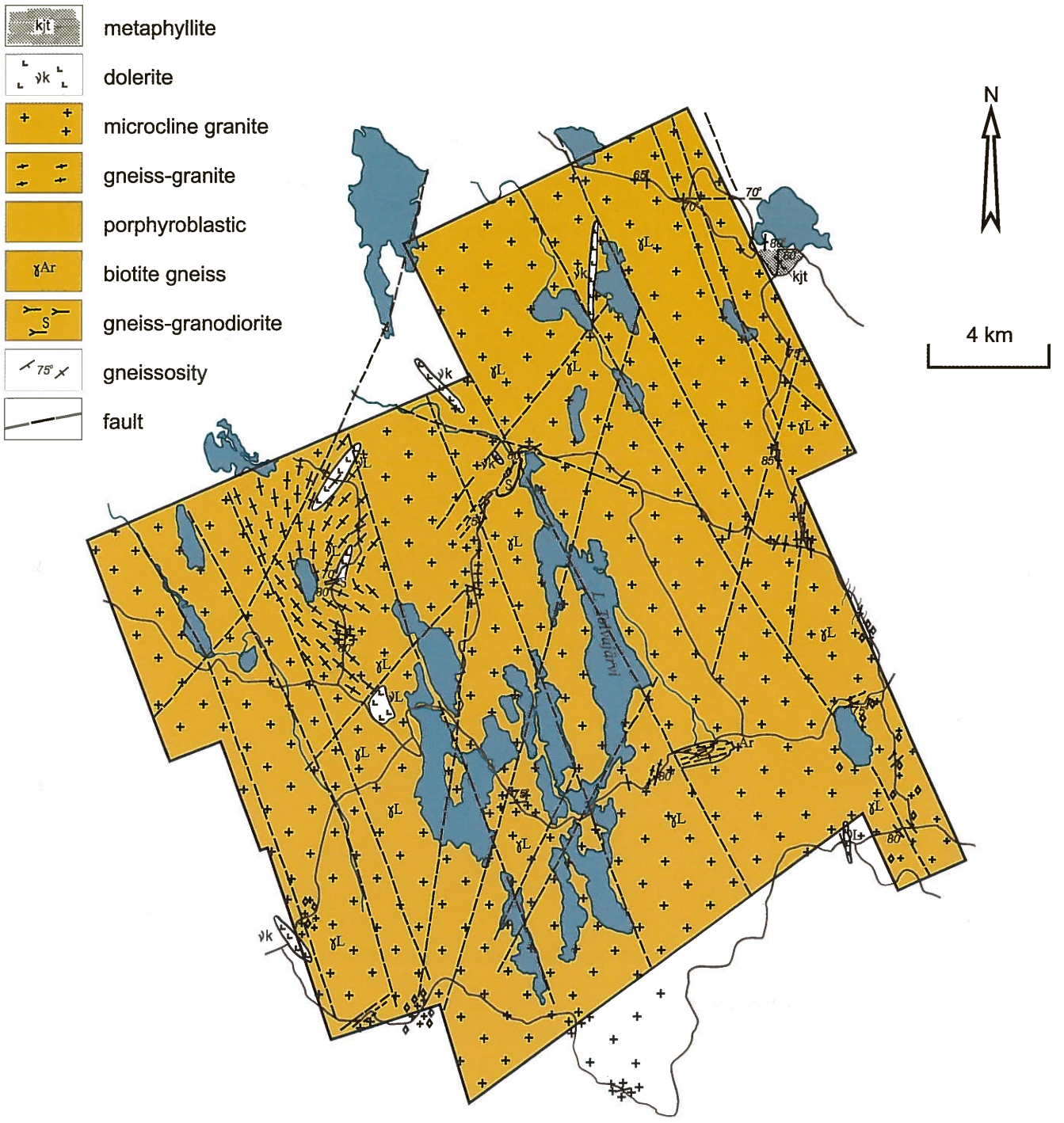


Fig. 7. Geological map of the proposed Tolvajärvi National Park.

References

Bibikova, E. V., Bergman, I. A., Gracheva, T. V. & Makarova, V. A. 1975: Arkheiskiy vozrast zhelezorudnykh phormatsiy Karelii. Geokhronologia problemy rudoobrazovaniya. – Moscow 65-69 p.

Geologia Karelii 1987: – "Nauka" Leningrad 231 pp.

Krats, K. O. 1963: Geologia karelid Karelii, LAGED AN SSSR, vip.16. 210 pp.

Lazarev, Yu. I. 1971: Structurnaia i metamorphicheskaya petrologia zhelezistykh kvartsitov Kostomukshskogo mestorozhdeniya. – Leningrad 192 pp.

Sviridenko, L. P. 1980: Granitoobrazovanie i problemy phormirovaniya dokembriyskoy zemnoy kory. – Leningrad 216 pp.

Assessment of the territory to be attached to the Kostamus Nature Reserve and its protection zone

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Abstract

The present study was conducted in the nature complexes adjoining the Kostamus State Nature Reserve on land owned by Kostamus City Council and the Mujejärvi District.

The goal of the study was a) to assess the above mentioned territories for the occurrence of rare and protected animal and plant species listed in the Red Data Books of Karelia (1995) and of the Russian Federation (1988); b) to have the boundaries of the territories to be incorporated into the reserve and its surrounding protection zone approved by local administrations and organisations whose interests are affected by the project; c) to outline a Provision for a Code of Management for managing the territories to be incorporated into the reserve and its protection zone.

The nature complexes known to exist in the study territory were assessed and their nature conservation value was estimated. Lists of especially valuable species, including those listed in the Red Data Books of Plants and Animals, are presented.

The proposals made and the results obtained by the organisations involved in the study of the territory in question were considered. Proposals were made to increase the area of the reserve and to establish a protection zone, an experimental biosphere site (wildlife area), a mire wildlife area and a number of sites of geological value. This work will be done in two stages.

During stage I a protection zone covering a total area of 40 836,5 hectares will be established around the reserve (Fig. 1).

Within the territory governed by Kostamus City Council the protection zone will cover 30 407,5 ha, including a special border strip over an area of 13 901 ha in the following compartments: 105–113, 125–126, 139–141, 145–147, 325–329 in the Latvajärvi Forest Estate, compartment 504 in the Kostamus Forest Estate (managed by the Kostamus Forestry Farm) and in the special border strip extending along the Russian–Finnish state border as far as compartment 120 in the Kiimasjärvi Forest Estate (managed by the Mujejärvi Forestry Farm).

In Mujejärvi District the protection zone will occupy an area of 10 429 ha, including a special border strip (980 ha) in compartments 1–3, 17, 28, 46, 64–66, and 120–122 in the Kiimasjärvi Forest Estate (Mujejärvi Forestry Farm).

During stage II issues pertaining to the establishment of an experimental biosphere site, i.e. forest wildlife area in compartments 70–78 and 87–88 of the Kiimasjärvi Forest Estate and in compartments 1–11 and 19–30 of the Saarenpää Forest Estate (Mujejärvi Forestry Farm) will be agreed upon.

The reserve area within the special border strip will be increased and mire wildlife area will be established along with sites of geological value in the territory governed by Kostamus City Council.

Key words: nature reserve, protection zone, biodiversity, primeval forest coenoses, nature protection, threatened and rare species

Introduction

S. V. Tarhov

Nature reserves (zapovednik) are a common form of nature conservation in Russia. The term 'zapovednik' was borrowed from the aboriginal population that protected groves, forests, rivers and lakes in accordance with monastic charters, tsars' acts and the traditional way of life of rural communes. Some zapovedniks were founded in areas marking the borders between principalities, in lands previously owned by monasteries and in the Tsar's hunting grounds. The Russian word 'Zapovedovanie' has three interrelated meanings: inviolable, forbidden, and left by testament.

In the end of 20 th century Russia has 99 nature reserves and 33 national parks which occupy approximately 2,0 % of its total land area.

State nature reserves and national parks provide a basis for Russia's network of specially protected native areas (SPNA).

Russian nature reserves fully represent all the natural ecosystems known to exist in the various landscape zones of Russia and contain populations and habitats of all the rare plant and animal species listed in the Red Data Book of Russia. Twenty–one Russian reserves are included in the international network of biosphere reserves representing world nature ecosystems. They fulfil a broad range of nature conservation, research and educational functions. Four reserves, including the Kostamus Nature Reserve, were granted Council of Europe Certificates. Some reserves are on the World Culture and Nature Heritage List.

Russian reserves function in accordance with Russian Federal Law concerning specially protected native areas, approved in March 1995 and according to which state nature reserves are defined as "native, research and educational institutions founded in order to preserve and study the evolution of natural processes and phenomena, the gene pools of the plant and animal kingdoms, individual plant and animal species, and communities". In order to maintain an effective management regime, protection zones are to be established around reserves, in which all types of activities that have a detrimental effect on the reserve are prohibited (Clause 61, Russian Federal Law 'On environmental protection').

The Kostamus Nature Reserve was established in accordance with Resolution No. 557, endorsed by the Council of Ministers on 14th December 1983, and became part of the Russian–Finnish Friendship Reserve in accordance with the Intergovernmental Soviet–Finnish Agreement on the Friendship Nature Reserve on the basis of Resolution No. 1036–p as approved by the Council of Ministers on 18th

September 1991. The reserve is located in the territory governed by Kostamus City Council and covers an area of 47 569 ha. It was founded in order to protect and study typical northern taiga. According to the original project, the reserve was to have covered an area about 120 000 ha, but in the course of discussions held with various departments its area was reduced to 47 569 ha.

Over the past fifteen years a number of attempts have been made to enlarge the reserve and establish a protection zone around it but most of these initiatives failed.

The aim of our work is to assess the areas adjoining the reserve to see if they really are unique and to find out if the reserve should be enlarged or if other types of protected areas should be established in adjacent territories. The authors of different chapters are responsible for the options and conclusions given in each chapter only.

Acknowledgements

The executors of the present report wish to thank Nikolai Bigun, a Kostamus City Council representative, Petr Hohlov, Chairman of the City Committee for Nature Conservation, and Nikolai Feofanov, Director of the Kostamus Forestry Farm, who helped to prepare the report.

We are also indebted to Valery Mamontov, Mayor of Kostamus, and Yuri Mamayev, Deputy Mayor, for their support in this project.

The present study is supported by the Life Fund of the European Union.

A study of the forests adjoining the Kostamus Nature Reserve: a basis for the expansion of the reserve

O. V. Smirnova

The Kostamus Nature Reserve was founded in 1983. It covers an area of approximately 47 500 ha – less than half the area specified in the original project. The reserve incorporates Lake Kiitehenjärvi which makes up over 20 % of its area. The forests that adjoin Lake Kiitehenjärvi and the River Kivijoki were significantly affected by human activities in the past. Thus, the reserve is made up of quite young, predominantly post–fire communities damaged by fires occurring 30–150 years ago. Localities of higher nature conservation value that incorporate more mature forest communities lie outside the protected territory. It is necessary, therefore, to study the forest ecosystems in the adjacent areas and to outline recommendations for the optimisation of the reserve area.

The territory which incorporates compartments 1–4 and 20–23 in the Saarenpää (Konetsostrov) Forest Estate and compartments 68–70 and 86 in the Kiimasjärvi Forest Estate (Mujejärvi Forestry Farm) was investigated from 12th to 17th July, 1998. The territory adjoining the eastern boundary of the Kostamus Nature Reserve, i.e. compartments 1–3, 17–19 and 28–29 in the Kiimasjärvi Forest Estate (Mujejärvi Forestry Farm), was studied from 17th to 24th July, 1998.

During the course of the study some 50 descriptions of forest vegetation were made, about 20 remarkable and protected plant species were recorded and the absolute ages of about 80 trees were estimated from age core samples.

Geobotanical characteristics of forest communities

Geobotanical descriptions were undertaken in the most characteristic and interesting parts of the forest communities, using the Brown–Blanquet method (Tables 1–5, Fig. 1). The descriptions of bryophyte and lichen synusia include only the most characteristic and abundant species. Further studies are needed to throw more light on the species composition of these groups. The storeys distinguished in geobotanical studies were: **A**. a woody storey, **B**. an undergrowth storey, **C**. field layer and **D**. ground layer. The frequency of each species is given in the Braun–Blanquet scale from 1 to 5. The coverage percentages of species in each storey were estimated using the following scale: 76–100 per cent coverage – grade 5, 51–75 per cent coverage – grade 4, 26–50 per cent coverage – grade 3, 11–25 per cent coverage – grade 2, 2–10 per cent coverage – grade 1, and under 2 per cent coverage – +. The area described was about one ha in size.

Fig. 1. The location of geobotanical descriptions in the area south of Kostamus Zapovednik (dots).

The age, condition, vitality, diameter at a height of 1,3 m and total height of representative trees were determined. An age drill was used to determine absolute ages.

Based on the transit study of the territory, the following major types of forest biotopes were identified: 1. dwarf shrub – green moss pine stands with undergrowth and a secondary spruce storey; 2. dwarf shrub – green moss pine stands with old pines; 3. herb grass – bilberry pine stands restricted to the lower parts of slopes; 4. creek spruce stands growing on and river flood plains (Table 1).

The most commonly encountered forest biotopes within the study area were types 1 and 2 growing on watersheds (Tables 1, 2, 3). They are floristically similar to the undisturbed forests which grew there earlier, but the species diversity of their tree, shrub and grass synusia is poorer owing to the occurrence of numerous large-scale fires indicated by coal layers in the soil, burnt dead wood, windfallen wood and fire scars on old pine trees. The most recent of these fires broke out 30–150 years ago. As a result of repeated fires the soils were markedly impoverished; plants and animals, especially soil populations, became far less abundant (Kuleshova et al. 1997).

Dwarf shrub – green moss pine stands with undergrowth and a secondary spruce storey (Table 1, biotope 1; Table 2) are typically restricted to the tops of ridges and the upper and middle parts of slopes that are most likely to have been affected by fires. Storey A is dominated by pine, the percentages of birch and spruce being small. The formation of a dominant pine generation usually follows a substantial disturbance caused by fire. In addition, multiple low fires that damage pines and destroy regenerating spruce stands can occur subsequently. Once fire disturbances are over, spruce regenerates and subsequently forms undergrowth and secondary storeys. Storey C is so called green moss type: it is dominated by *Vaccinium myrtillus, V. vitis–idaea* and occasionally *Empetrum hermaphroditum*. The impoverished vascular plant synusia consist chiefly of *Deschampsia flexuosa* and *Melampyrum pratense*. Storey D is dominated by *green mosses: Pleurozium schreberi, Hylocomium splendens* and less commonly *Ptilium crista–castrensis*, the percentage of lichens being small. The lichen synusia, which evolve well only in the initial stages of post–fire succession, consists chiefly of *Cladonia rangiferina* and *C. mitis*.

Dwarf shrub – green moss spruce stands with old pine trees (Table 1, biotope 2; Table 3) differ from the previous type of biotope in the much smaller percentage or complete absence of pine in the uppermost storey. Combinations of spruce populations of differing age have already been formed. This is highly valuable for the preservation of the gene pool of this species. The field layer is still dominated by *Vaccinium myrtillus* and *V. vitis–idaea*, whereas herbs are poorly represented. Storey D is dominated by green mosses and has no lichen synusia.

Herb – bilberry spruce stands (Table 1, biotope 3) comprise a fairly rare type of forest community within the study area. They are encountered in the lower parts of slopes where ground water wedges out and prevents any damage to these zones by fires even in the driest of years. The primary storey is composed of spruce and birch, aspen and grey alder being less abundant. Undergrowth is made up of grey alder, mountain ash, juniper, and goat willow. In addition to *Vaccinium myrtillus* and *V. vitis–idaea* that grow on microtopographic elevations, grasses are well represented in storey C. Ferns *(Gymnocarpium dryopteris, Athyrium filix–fimina), Equisetum sylvaticum, Rubus saxatilis* and *Geranium sylvaticum* prevail. The occurrence of some nemoral species, such as *Melica nutans, Paris quadrifolia, Milium effusum* is characteristic (Table 4).

Spruce stands (Table 1, biotope 4, Table 5) constitute a common type of forest coenosis in the study area. They evolve in river, creek and temporary watercourse valleys. Spruce stands growing along creeks are floristically highly valuable forest communities. The fern, woody shrub and herbaceous vascular plant synusia found

in these communities are the most diverse in the entire study area. The gap mosaic, characteristic of undisturbed forest communities, is intact. Creek spruce stands are made up of species belonging to various ecological–coenotic groups with a range of habitats created by the formation of wind–soil complexes, the occurrence of unequally decomposed windfallen wood, animal activities, etc. The standing timber comprises spruce together with birch. The shrub layer, consisting of spruce, birch and grey alder undergrowth together with *Mountain ash* and *Salix phylicifolia*, is well developed. The herb layer is dominated by *Athyrium filix–femina, Phegopteris connectilis, Gymnocarpium dryopteris, Equisetum sylvaticum, E. palustre, Carex canescens, Potentilla palustris, Viola epipsila* etc. Boreal species, e.g. *Vaccinium myrtillus, Vaccinium vitis–idaea, Linnaea borealis, Pleurozium schreberi, Hylocomium splendens,* and *Dicranum scoparium* are well represented.

Table 1. Geobotanical characteristics of major types of forest biotopes

Type of biotope	1		2		3		4	
Number of descriptions	11		5		7		22	
	Freq.	Occur	Freq.	Occur	Freq.	Occur	Freq.	Occur
Storey A, total cover %		30		35		51		39
Betula pubescens Ehrh.	2	1	3	1	5	1	5	1
Picea abies ssp. obovata. (Ledeb.) Hultén	5	1	5	3	5	3	5	2
Pinus sylvestris L.	4	2	4	1	2	2	–	–
Populus tremula L.	1	1	–	–	1	2	1	2
Alnus incana (L.) Moench	–	–	–	–	1	1	1	3
Betula pendula Roth.	1	1	–	–	–	–	–	–
Storey B, total cover %		22		25		18		24
Picea abies ssp. obovata. (Ledeb.) Hultén	5	2	5	2	5	1	5	2
Alnus incana (L.) Moench.	1	1	–	–	4	1	2	2
Betula pubescens Ehrh.	4	1	3	+	1	+	4	1
Salix caprea L.	1	+	1	1	2	+	1	1
Sorbus gorodkovii Pojark.	2	+	1	+	5	1	3	1
Betula pendula Roth.	–	–	–	–	1	2	1	+
Juniperus communis L.	1	+	–	–	2	+	1	+
Pinus sylvestris L.	1	+	–	–	–	–	1	+
Populus tremula L.	1	+	–	–	1	+	–	–
Salix phylicifolia L.	–	–	–	–	–	–	1	1
Salix spp.	–	–	–	–	–	–	1	1
Prunus padus L.	–	–	–	–	–	–	1	+

Type of biotope	1		2		3		4	
Number of descriptions	11		5		7		22	
	Freq.	Occur	Freq.	Occur	Freq.	Occur	Freq.	Occur
Storey C, total cover %	69		54		83		80	
Sorbus gorodkovii Pojark.	2	+	3	+	3	1	3	+
Betula pubescens Ehrh.	2	+	1	+	1	+	4	+
Picea abies ssp. obovata (Ledeb.) Hultén	3	+	3	+	2	+	4	+
Alnus incana (L.) Moench.	–	–	–	–	1	1	1	+
Juniperus communis L.	1	+	–	–	1	+	1	+
Populus tremula L.	1	+	–	–	1	+	1	+
Prunus padus L.	–	–	–	–	–	–	1	1
Pinus sylvestris L.	1	+	–	–	–	–	1	+
Salix caprea L.	1	+	–	–	1	+	–	–
Betula nana L.	–	–	–	–	–	–	1	+
Betula pendula Roth.	1	+	–	–	–	–	–	–
Rosa majalis Herrm.	–	–	–	–	–	–	1	+
Salix phylicifolia L.	–	–	–	–	–	–	1	+
Equisetum sylvaticum L.	1	1	2	1	3	2	4	1
Vaccinium myrtillus L.	5	3	5	2	5	2	4	1
Vaccinium vitis-idaea L.	5	2	5	2	5	2	5	1
Carex globularis L.	1	1	2	3	4	+	2	1
Rubus chamaemorus L.	1	+	2	2	1	1	3	1
Vaccinium uliginosum L.	2	1	2	1	1	1	1	+
Ledum palustre L.	1	1	1	+	1	1	1	+
Deschampsia flexuosa (L.) P. Beauv.	5	+	5	+	4	1	2	1
Linnaea borealis L.	2	+	4	+	5	1	5	1
Melampyrum pratense L.	4	1	3	+	3	1	2	+
Cornus suecica L.	–	–	1	+	2	2	1	1
Empetrum hermaphroditum Hager	3	1	2	1	–	–	1	+
Orthilia secunda (L.) House	1	+	2	+	5	1	3	+
Solidago virgaurea L.	1	+	–	–	5	1	3	1
Athyrium filix-femina (L.) Roth	–	–	–	–	2	1	3	1
Calamagrostis purpurea ssp. phragmitoides (Hartm.) Tzvelev	–	–	–	–	4	1	5	1
Carex vaginata Tausch	–	–	–	–	3	1	2	1
Epilobium palustre L.	–	–	–	–	–	–	1	+
Eriophorum vaginatum L.	–	–	1	+	–	–	–	–
Galium palustre L.	–	–	–	–	–	–	2	+
Galium uliginosum L.	–	–	–	–	–	–	1	+
Goodyera repens (L.) R.Br.	1	+	–	–	–	–	–	–
Huperzia selago (L.) Schrank et Mart.	–	–	–	–	–	–	1	+
Lysimachia thyrsiflora (L.)	–	–	–	–	–	–	2	+
Pyrola rotundifolia L.	–	–	–	–	–	–	1	+
Ranunculus acris L.	–	–	–	–	–	–	1	+
Ranunculus repens L.	–	–	–	–	–	–	1	+
Scutellaria galericulata L.	–	–	–	–	–	–	1	+

Type of biotope	1		2		3		4	
Number of descriptions	11		5		7		22	
	Freq.	Occur	Freq.	Occur	Freq.	Occur	Freq.	Occur
Storey D, total cover %		97		89		74		65
Hylocomium splendens (Hedw.)B.S.G.	5	2	4	2	4	2	3	1
Pleurozium schreberi (Brid.) Mitt.	5	4	5	3	4	2	3	1
Polytrichum commune Hedw.	1	1	3	2	1	2	3	1
Ptilium crista-castrensis (Hedw.)De Not.	2	2	2	2	1	1	1	1
Sphagnum spp.	1	2	3	2	4	2	5	3
Dicranum spp.	5	1	3	+	3	1	1	+
Mnium spp.	–	–	–	–	1	2	3	1
Barbilophozia spp.	1	+	–	–	1	1	–	–
Aulacomnium palustre (Hedw.)Schwaegr.	–	–	–	–	2	1	–	–
Cladina rangiferina (L.) Harm.	3	1	–	–	–	–	–	–
Cladina mitis Sandst.	2	1	–	–	–	–	–	–
Cladonia spp.	2	1	–	–	–	–	–	–
Rhytidiadelphus triquetrus (Hedw.) Warnst.	–	–	–	–	1	3	–	–
Cetraria islandica (L.) Ach.	1	+	–	–	–	–	–	–
Cladina alpestris (L.) Rabenh.	1	+	–	–	–	–	–	–
Marchantia polymorpha L.	–	–	–	–	–	–	1	+
Polytrichum juniperinum Hedw.	1	+	–	–	–	–	–	–

Table 2. Geobotanical descriptions of dwarf shrub/green moss pine stands with a secondary spruce storey (biotope 1 type)

Number of descriptions	15-1	15-2	15-3	15-5	14-4	18-1	18-6	18-7	20-3	18-11
Compartment	2	2	2	2	2	28	28	28	1	17
Storey A, total cover %	30	20	15	10	35	50	60	30	20	30
Picea abies ssp. obovata (Ledeb.) Hultén	2	1	1	1	2	1	1	2	+	2
Pinus sylvestris L.	2	1	–	1	2	3	3	2	2	2
Betula pubescens Ehrh.	–	–	–	–	1	1	1	–	1	1
Betula pendula Roth.	–	–	–	–	–	1	1	+	–	–
Populus tremula L.	–	–	–	–	–	–	1	–	–	–
Storey B, total cover %	30	10	30	10	30	5	1	40	25	20
Picea abies ssp. obovata (Ledeb.) Hultén	3	1	2	1	2	1	+	3	2	2
Betula pubescens Ehrh.	1	–	1	–	1	+	+	+	–	2
Sorbus gorodkovii Pojark.	–	–	–	–	–	+	+	+	+	+
Alnus incana (L.) Moench.	–	–	–	–	–	1	–	–	1	–
Juniperus communis L.	–	–	–	–	–	+	–	–	+	–
Pinus sylvestris L.	–	–	–	+	–	–	–	–	–	–
Populus tremula L.	–	–	–	–	–	–	–	–	–	+
Salix caprea L.	–	–	–	–	–	–	–	+	–	–

Number of descriptions	15-1	15-2	15-3	15-5	14-4	18-1	18-6	18-7	20-3	18-11
Compartment	2	2	2	2	2	28	28	28	1	17
Storey C, total cover %	60	50	60	60	40	80	70	90	90	80
Vaccinium myrtillus L.	3	3	4	3	3	4	4	4	2	4
Vaccinium vitis-idaea L.	3	3	2	3	2	2	2	1	3	2
Deschampsia flexuosa (L.) P. Beauv.	1	–	+	+	1	+	+	+	+	2
Melampyrum pratense L.	+	+	–	–	–	1	1	1	1	1
Picea obovata Ledeb.	1	+	+	1	–	–	–	–	+	+
Empetrum hermaphroditum Hager	+	–	–	+	–	–	1	2	2	2
Betula pubescens Ehrh.	+	+	+	+	–	–	+	–	–	–
Sorbus gorodkovii Pojark.	–	–	–	–	+	–	+	1	+	–
Linnaea borealis L.	–	–	–	–	+	1	–	+	–	+
Vaccinium uliginosum L.	–	–	–	–	–	+	1	2	1	–
Calluna vulgaris (L.) Hull	–	–	–	–	–	+	+	–	2	–
Ledum palustre L.	–	–	–	–	–	+	–	1	–	1
Salix caprea L.	–	–	–	–	–	–	+	–	–	+
Solidago virgaurea L.	–	–	–	–	–	+	+	–	–	–
Betula pendula Roth.	–	–	–	+	–	–	–	–	–	–
Juniperus communis L.	–	–	–	–	–	–	–	–	–	+
Pinus sylvestris L.	–	–	+	–	–	–	–	–	–	–
Populus tremula L.	–	–	–	–	–	–	–	–	–	+
Carex globularis L.	–	–	–	–	–	–	–	1	–	–
Epilobium angustifolium L.	–	–	–	–	–	+	–	–	–	–
Equisetum sylvaticum L.	–	–	–	–	–	–	–	1	–	–
Goodyera repens (L.) R.Br.	–	–	–	–	–	+	–	–	–	–
Luzula pilosa (L.) Willd.	–	–	–	–	+	–	–	–	–	–
Orthilia secunda (L.) House	–	–	–	–	–	–	–	+	–	–
Rubus chamaemorus L.	–	–	–	–	–	–	–	+	–	–
Storey D, total cover %	95	98	98	98	98	90	99	98	98	98
Dicranum spp.	1	1	1	1	1	1	1	1	2	2
Pleurozium schreberi (Brid.) Mitt.	5	5	5	5	5	3	5	3	4	5
Hylocomium splendens (Hedw.) B.S.G.	1	2	2	2	2	2	1	–	3	2
Cladina rangiferina (L.) Harm.	2	1	1	1	–	–	+	–	1	–
Ptilium crista-castrensis (Hedw.) De Not.	–	–	–	1	1	3	–	2	–	–
Cladina mitis Sandst.	+	1	1	–	–	–	–	–	–	–
Cladonia spp.	–	1	1	–	–	–	–	–	–	+
Polytrichum commune Hedw.	+	–	–	1	–	–	–	1	–	–
Polytrichum juniperinum Hedw.	+	+	1	–	–	–	–	–	–	–
Barbilophozia spp.	+	+	–	–	–	–	–	–	–	–
Sphagnum spp.	–	–	–	–	–	+	–	4	–	–
Cetraria islandica (L.) Ach.	+	–	–	–	–	–	–	–	–	–
Cladina alpestris (L.) Rabenh.	–	–	–	–	–	–	+	–	–	–

Table 3. Geobotanical descriptions of dwarf shrub/green moss spruce stands with old pines (biotope 2 type)

Number of descriptions	13-1	19-3	20-2	14-4	14-6
Compartment	2	1	1	1-2	1-2
Storey A, total cover %	30	30	40	35	40
Picea abies ssp. obovata (Ledeb.) Hultén	2	3	3	2	3
Pinus sylvestris L.	1	1	1	2	–
Betula pubescens Ehrh.	1	–	1	1	–
Storey B, total cover %	20	35	20	30	20
Picea abies ssp. obovata (Ledeb.) Hultén	2	3	2	2	2
Betula pubescens Ehrh.	–	+	+	1	–
Salix caprea L.	–	1	–	–	–
Sorbus gorodkovii Pojark.	–	+	–	–	–
Storey C, total cover %	70	60	75	35	30
Picea abies ssp. obovata (Ledeb.) Hultén	+	+	–	–	+
Sorbus gorodkovii Pojark.	+	–	+	+	–
Betula pubescens Ehrh.	–	+	–	–	–
Deschampsia flexuosa (L.) P. Beauv.	+	+	+	1	1
Vaccinium myrtillus L.	3	3	2	3	1
Vaccinium vitis-idaea L.	2	2	2	2	2
Linnaea borealis L.	+	–	+	+	1
Luzula pilosa (L.) Willd.	–	–	+	+	+
Melampyrum pratense L.	+	+	+	–	–
Carex globularis L.	–	2	3	–	–
Empetrum hermaphroditum Hager	1	1	–	–	–
Equisetum sylvaticum L.	–	2	+	–	–
Orthilia secunda (L.) House	–	+	+	–	–
Rubus chamaemorus L.	–	2	–	–	1
Vaccinium uliginosum L.	1	+	–	–	–
Cornus suecica L.	–	–	–	–	+
Eriophorum vaginatum L.	–	+	–	–	–
Ledum palustre L.	–	+	–	–	–
Listera cordata (L.) R.Br.	–	+	–	–	–
Vaccinium oxycoccos L.	–	+	–	–	–
Storey D, total cover %	90	95	80	98	80
Pleurozium schreberi (Brid.) Mitt.	2	3	4	5	3
Hylocomium splendens (Hedw.) B.S.G.	3	2	2	2	–
Dicranum spp.	+	–	+	1	–
Polytrichum commune Hedw.	–	1	2	–	2
Sphagnum spp.	–	3	1	–	2
Ptilium crista-castrensis (Hedw.) De Not.	–	–	1	–	2

Table 4. Geobotanical descriptions of bilberry/herb grass spruce stands on the lower parts of slopes (biotope 3 type)

Number of descriptions	21-4	16-5	20-1	18-2	18-5	21-5	18-4
Compartment	28	1-86	1	28	29	28	28
Storey A, %	20	60	60	40	50	60	70
Betula pubescens Ehrh.	1	1	1	+	2	+	2
Picea abies ssp.obovata (Ledeb.) Hultén	2	3	3	3	1	4	4
Pinus sylvestris L.	–	1	–	1	3	–	–
Populus tremula L.	–	1	2	–	–	–	–
Alnus incana (L.) Moench.	–	–	–	–	–	–	1
Storey B, %	20	5	10	10	60	2	20
Picea abies ssp. obovata (Ledeb.) Hultén	2	1	1	1	1	+	1
Sorbus gorodkovii Pojark.	1	1	1	1	1	+	1
Alnus incana (L.) Moench.	1	–	–	1	3	+	1
Juniperus communis L.	–	–	–	+	1	–	+
Salix caprea L.	+	+	–	–	–	+	–
Betula pendula Roth.	–	–	–	+	3	–	–
Betula pubescens Ehrh.	–	–	–	–	–	–	+
Populus tremula L.	–	+	–	–	–	–	–
Storey C, %	95	90	60	70	95	80	90
Sorbus gorodkovii Pojark.	1	–	+	1	–	+	–
Picea abies ssp. obovata (Ledeb.) Hultén	+	–	+	–	–	+	–
Betula pubescens Ehrh.	–	–	–	+	–	+	–
Salix caprea L.	+	–	–	–	–	+	–
Alnus incana (L.) Moench.	–	–	–	–	1	–	–
Juniperus communis L.	–	–	–	–	+	–	–
Populus tremula L.	–	–	–	+	–	–	–
Epilobium angustifolium L.	1	1	+	+	1	1	+
Gymnocarpium dryopteris (L.) Newm.	2	2	2	3	1	3	3
Linnaea borealis L.	1	1	1	1	1	+	1
Maianthemum bifolium (L.) F.W.Schmidt.	+	+	1	1	1	1	1
Orthilia secunda (L.) House	1	+	+	+	1	1	1
Solidago virgaurea L.	1	1	+	1	1	1	1
Vaccinium myrtillus L.	1	2	2	2	3	+	2
Vaccinium vitis-idaea L.	2	2	1	1	2	1	2
Listera cordata (L.) R.Br.	+	1	+	+	+	+	–
Rubus saxatilis L.	1	2	–	1	2	2	2
Trientalis europaea L.	–	1	1	1	1	1	1
Calamagrostis purpurea ssp. phragmitoides (Hartm.) Tzvelev	+	–	–	1	1	1	+
Carex globularis L.	–	+	–	1	1	+	+
Deschampsia flexuosa (L.) P.Beauv.	1	1	1	+	1	–	–
Luzula pilosa (L.) Willd.	+	+	1	–	–	+	1
Lycopodium annotinum L.	–	–	1	+	1	+	+
Carex vaginata Tausch	–	–	–	1	1	1	1
Equisetum sylvaticum L.	–	–	–	1	1	3	3
Melampyrum pratense L.	–	1	+	1	1	–	–
Angelica sylvestris L.	+	–	–	1	+	–	–

Number of descriptions	21-4	16-5	20-1	18-2	18-5	21-5	18-4
Compartment	28	1-86	1	28	29	28	28
Athyrium filix-femina (L.) Roth.	–	–	–	1	3	+	–
Cornus suecica L.	3	–	+	2	–	–	–
Cirsium helenioides (L.) Hill	2	–	–	1	–	1	–
Dactylorhiza maculata (L.) Soo	+	+	–	+	–	–	–
Geranium sylvaticum L.	–	2	–	2	2	–	–
Melica nutans L.	1	1	–	–	1	–	–
Phegopteris connectilis (Michx.) Watt	–	2	–	–	1	3	–
Pyrola media Sw.	+	–	–	–	–	2	1
Carex loliacea L.	–	–	–	–	+	+	–
Equisetum palustre L.	–	–	–	+	–	–	1
Filipendula ulmaria (L.) Maxim.	–	–	–	–	–	1	2
Hieracium diaphanoides coll. Lindeb.	1	1	–	–	–	–	–
Ledum palustre L.	–	–	–	1	1	–	–
Moneses uniflora (L.) A. Gray	–	+	–	–	–	1	–
Paris quadrifolia L.	–	–	–	–	–	2	1
Rubus chamaemorus L.	–	–	–	1	–	–	1
Viola epipsila Ledeb.	–	–	–	–	–	1	+
Carex dioica L.	–	–	–	–	+	–	–
Carex disperma Dew.	–	–	–	–	+	–	–
Carex pauciflora Lightf.	–	–	–	+	–	–	–
Chamaedaphne calyculata (L.) Moench	–	–	–	–	1	–	–
Convallaria majalis L.	–	–	–	–	2	–	–
Corallorhiza trifida Chatel.	–	–	–	–	–	+	–
Dryopteris carthusiana (Vill.) H.P.Fuchs	–	–	–	–	–	+	–
Equisetum fluviatile L.	–	–	–	–	–	–	+
Equisetum pratense Ehrh.	–	–	–	–	–	1	–
Hieracium vulgatum Fries.	–	–	–	1	–	–	–
Milium effusum L.	–	–	–	–	–	1	–
Vaccinium uliginosum L.	–	–	–	–	1	–	–
Storey D, %	90	80	80	90	20	90	70
Hylocomium splendens (Hedw.) B.S.G.	3	–	2	1	1	2	1
Pleurozium schreberi (Brid.) Mitt.	3	5	2	2	1	1	
Sphagnum spp.	–	1	1	4	1	3	1
Dicranum spp.	+	1	2	1	–	–	–
Aulacomnium palustre (Hedw.) Schwaegr.	–	–	–	1	2	–	+
Mnium spp.	–	–	–	–	–	3	1
Rhytidiadelphus triquetrus (Hedw.) Warnst.	–	–	–	–	–	2	4
Barbilophozia spp.	–	–	–	1	–	–	–
Polytrichum commune Hedw.	–	–	2	–	–	–	–
Ptilium crista-castrensis (Hedw.) De Not.	–	–	–	1	–	–	–

Table 5. Geobotanical descriptions of creek spruce stands growing on creek and river flood plains (biotope 4 type)

Number of descriptions	20-4	21-1	21-2	21-3	19-1	13-3	13-2	14-5	19-2	19-4	16-4	16-1	13-2	14-5	17-1	18-15	18-12	18-13	18-14	18-3	19-10	23-1
No, of compartment	17	17	17	17	1	2	2	1-2	1	1	2	68	2	1-2		17	1-17	17	17	28	17	3
Storey A, %	45	50	25	30	20	40	50	40	70	75	25	30	50	40	20	30	20	30	20	60	40	50
Picea abies ssp. obovata (Ledeb.) Hultén	3	3	2	2	1	3	3	3	4	3	+	3	3	3	1	2	2	3	2	+	2	3
Betula pubescens Ehrh.	2	1	1	1	2	1	1	1	2	1	–	1	1	1	1	2	+	1	1	1	–	2
Populus tremula L.	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	2	1
Alnus incana (L.) Moench.	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	4	–	–
Storey B, %	20	15	10	20	60	30	20	25	25	15	25	20	20	30	5	30	30	40	30	20	10	30
Picea abies ssp. obovata (Ledeb.) Hultén	2	2	2	2	2	3	2	2	1	2	5	2	2	2	–	2	2	2	3	1	2	2
Betula pubescens Ehrh.	+	1	+	1	2	+	–	1	–	+	3	–	–	1	+	1	1	2	2	1	–	1
Sorbus gorodkovii Pojark.	+	+	+	1	–	1	–	–	+	+	1	–	–	–	+	+	–	1	2	–	–	1
Alnus incana (L.) Moench.	–	–	–	–	3	–	–	–	2	–	–	–	–	–	–	2	2	2	–	2	–	2
Salix phylicifolia L.	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	+	2	–	1	–	+
Juniperus communis L.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	+	–	1	–	–	–	–	–
Salix caprea L.	–	–	–	+	2	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
Prunus padus L.	+	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinus sylvestris L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+
Salix spp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	1	–	–	–	–
Betula pendula Roth.	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Storey C, %	80	90	95	95	85	80	60	70	80	65	80	80	60	70	70	88	80	80	80	98	80	95
Betula pubescens Ehrh.	+	–	1	+	1	1	+	+	+	–	+	+	+	+	+	–	+	+	–	–	+	+
Picea abies ssp. obovata (Ledeb.) Hultén	+	–	1	+	+	+	+	1	–	+	+	+	+	1	–	+	–	+	+	–	–	+
Sorbus gorodkovii Pojark.	+	1	1	+	–	–	–	+	+	+	1	1	–	+	–	+	–	+	+	–	+	–
Salix phylicifolia L.	+	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–
Prunus padus L.	1	+	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Populus tremula L.	–	–	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–
Alnus incana (L.) Moench.	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–	–	–	–	–	–
Betula nana L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–
Pinus sylvestris L.	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Juniperus communis L.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Rosa majalis Herrm.	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Number of descriptions	20-4	21-1	21-2	21-3	19-1	13-3	13-2	14-5	19-2	19-4	16-4	16-1	13-2	14-5	17-1	18-15	18-12	18-13	18-14	18-3	19-10	23-1
No, of compartment	17	17	17	17	1	2	2	1-2	1	1	2	68	2	1-2		17	1-17	17	17	28	17	3
Gymnocarpium dryopteris (L.) Newm.	1	3	2	2	1	3	3	2	2	2	2	1	3	2	3	1	2	2	3	1	1	3
Trientalis europaea L.	+	+	+	+	1	1	+	1	+	+	+	1	+	1	1	+	+	+	1	1	+	+
Calamagrostis purpurea ssp. phragmitoides (Hartm.) Tzvelev	1	1	1	1	2	+	+	1	3	2	1	1	+	1	–	1	+	3	1	3	3	2
Vaccinium vitis-idaea L.	1	1	1	1	–	3	2	+	2	2	2	2	2	+	1	1	1	2	2	1	1	2
Carex canescens L.	+	1	–	1	2	+	+	1	1	+	+	+	+	1	–	2	1	2	+	1	2	1
Linnaea borealis L.	1	1	1	1	1	1	+	1	1	+	2	–	+	1	+	+	+	+	2	–	+	+
Maianthemum bifolium (L.) F.W.Schmidt	+	1	+	1	1	2	1	+	1	2	1	–	1	+	1	+	–	+	1	1	+	+
Vaccinium myrtillus L.	+	1	+	+	1	+	–	1	2	2	1	+	–	1	1	1	1	2	2	–	+	1
Potentilla palustris (L.) Scop.	+	+	+	–	2	+	+	–	2	2	+	+	+	–	–	2	+	+	+	3	1	3
Equisetum sylvaticum L.	+	2	+	2	3	–	+	2	3	–	2	1	+	2	1	1	1	–	3	–	+	3
Lycopodium annotinum L.	+	1	+	1	–	1	+	+	1	1	1	–	+	+	–	+	+	1	1	1	–	1
Phegopteris connectilis (Michx.) Watt	3	3	3	3	+	1	2	1	1	–	–	1	2	1	–	1	+	–	2	–	1	2
Epilobium angustifolium L.	–	+	–	1	1	+	+	–	–	+	+	+	+	–	1	+	+	–	1	–	2	1
Viola epipsila Ledeb.	1	+	1	+	2	+	+	–	–	+	–	1	+	–	–	+	–	+	–	1	–	–
Athyrium filix-femina (L.) Roth.	2	+	2	2	1	2	1	–	–	–	–	3	1	–	3	+	–	–	–	–	+	–
Listera cordata (L.) R.Br.	–	+	–	+	–	+	+	1	–	–	+	–	+	1	–	+	–	+	+	–	–	+
Rubus arcticus L.	+	+	–	+	1	1	–	–	+	2	–	1	–	–	–	–	+	+	–	+	1	–
Filipendula ulmaria (L.) Maxim.	2	+	2	1	1	–	–	–	+	1	1	–	–	–	–	–	1	–	–	3	–	2
Orthilia secunda (L.) House	+	1	+	+	1	+	–	+	+	–	1	–	–	+	–	–	+	–	–	–	–	–
Rubus chamaemorus L.	+	–	–	–	–	1	–	2	2	–	+	–	–	2	–	1	1	2	1	–	–	2
Solidago virgaurea L.	+	1	1	1	+	–	–	–	–	1	+	–	–	–	1	–	1	+	–	–	1	–
Carex globularis L.	+	1	–	–	–	1	–	+	–	–	1	–	–	+	+	–	–	2	1	–	–	+
Carex loliacea L.	+	–	1	+	2	–	–	+	–	–	–	–	–	+	–	–	–	+	+	1	–	1
Galium palustre L.	+	–	+	+	1	–	–	–	–	+	–	–	–	–	–	–	+	+	+	+	+	–
Luzula pilosa (L.) Willd.	+	–	+	+	–	–	+	+	–	–	+	+	+	+	–	–	–	–	+	–	–	–
Pyrola media Sw.	+	+	–	+	1	–	–	–	+	–	–	+	–	–	+	–	+	–	–	+	–	+
Deschampsia flexuosa (L.) P. Beauv	–	+	–	–	–	2	+	–	–	1	+	–	+	–	+	–	1	–	–	–	1	–
Melampyrum pratense L.	+	–	–	–	–	–	+	–	+	–	–	–	+	–	+	+	+	+	–	–	+	–
Melica nutans L.	+	+	1	1	–	–	–	–	–	–	–	–	–	–	–	+	+	+	+	–	–	+
Lysimachia thyrsiflora L.	+	–	+	+	–	–	–	–	1	1	–	+	–	–	–	–	+	+	–	–	+	–

Number of descriptions	20-4	21-1	21-2	21-3	19-1	13-3	13-2	14-5	19-2	19-4	16-4	16-1	13-2	14-5	17-1	18-15	18-12	18-13	18-14	18-3	19-10	23-1
No, of compartment	17	17	17	17	1	2	2	1-2	1	1	2	68	2	1-2		17	1-17	17	17	28	17	3
Carex vaginata Tausch	+	–	–	+	–	–	–	–	–	–	1	–	–	–	1	–	+	1	–	–	–	1
Equisetum palustre L.	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	2	1	2	+	2	–	2
Geranium sylvaticum L.	1	1	2	2	1	–	–	–	–	–	2	–	–	–	2	–	–	–	–	–	–	–
Rubus saxatilis L.	1	1	2	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	1
Cornus suecica L.	–	–	–	–	+	–	–	1	–	–	2	–	–	1	–	1	–	–	1	–	–	–
Dryopteris carthusiana (Vill.) H.P.Fuchs	+	–	–	–	–	–	–	+	–	–	–	1	–	+	–	+	–	–	–	+	–	–
Caltha palustris L.	+	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	+	–	–	2	–	–
Phalaris arundinacea L.	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1	–
Angelica sylvestris L.	–	–	+	+	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Calla palustris L.	+	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–	–	–	–	–
Carex limosa L.	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	+
Chamaedaphne calyculata (L.) Moench	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	+	1	–	–	–	–
Corallorhiza trifida Chatel.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–	–	+
Equisetum pratense Ehrh.	+	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–
Galium uliginosum L.	–	+	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ledum palustre L.	–	–	–	–	–	–	–	–	+	–	–	–	–	–	+	–	1	–	–	–	–	–
Paris quadrifolia L.	+	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Scutellaria galericulata L.	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
Vaccinium uliginosum L.	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–	+	–
Deschampsia cespitosa (L.) Beauv.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–	–	–
Dryopteris assimilis S.Walker	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Empetrum hermaphroditum Hager	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–
Matteuccia struthiopteris (L.) Tod.	+	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Menyanthes trifoliata L.	–	–	–	–	–	–	–	–	2	–	–	+	–	–	–	–	–	–	–	–	–	–
Moneses uniflora (L.) A.Gray	–	+	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–
Calestania palustris (L.) K.-Pol.	+	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Rubus idaeus L.	+	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carex cespitosa L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Carex lasiocarpa Ehrh.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
Carex nigra (L.) Reichard	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–

Number of descriptions	20-4	21-1	21-2	21-3	19-1	13-3	13-2	14-5	19-2	19-4	16-4	16-1	13-2	14-5	17-1	18-15	18-12	18-13	18-14	18-3	19-10	23-1
No, of compartment	17	17	17	17	1	2	2	1-2	1	1	2	68	2	1-2		17	1-17	17	17	28	17	3
Carex rostrata Stokes	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
Cirsium helenioides (L.) Hill	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dactylorhiza maculata (L.) Soo	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Dryopteris cristata (L.) A.Gray	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Epilobium palustre L.	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Equisetum fluviatile L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Huperzia selago (L.) Schrank et Mart.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Juncus filiformis L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Vaccinium oxycoccos L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Pyrola rotundifolia L.	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–
Ranunculus acris L.	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ranunculus repens L.	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Storey D, %	50	60	30	15	80	98	40	80	95	80	–	–	–	–	–	85	80	98	90	10	30	90
Sphagnum spp.	2	3	1	1	4	4	2	4	5	4	3	3	2	4	5	4	2	4	4	1	1	5
Pleurozium schreberi (Brid.) Mitt.	2	1	2	1	1	2	2	1	2	1	–	–	–	–	–	1	2	2	2	–	–	+
Hylocomium splendens (Hedw.) B.S.G.	1	1	2	1	–	1	–	1	1	1	–	–	–	–	–	1	1	1	1	–	–	1
Mnium spp.	+	–	1	+	1	–	+	–	1	+	–	–	–	–	–	1	1	1	+	1	–	1
Polytricum commune Hedw.	+	1	1	+	1	2	1	1	–	+	–	–	–	–	–	1	1	1	1	–	–	–
Dicranum spp.	–	–	+	–	+	1	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Undet. bryophytes	–	–	–	–	–	–	–	–	–	–	4	3	–	–	–	–	–	–	–	–	3	–
Marchantia polymorpha L.	–	–	+	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ptilium crista-castrensis (Hedw.) De Not.	–	–	1	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

If no trees are felled and no fires or other disasters occur, then creek spruce stands will provide a source of diaspores for surrounding forested areas and will have a beneficial effect on the floristic diversity of adjacent forest communities.

Renewal felling technology, which needs to be tested out within the proposed experimental biosphere site, is one possible way of artificially increasing the biodiversity of bilberry/green moss spruce stands. It is desirable to combine narrow-strip and group felling with the encouragement of grey alder (a species which enriches soil with nitrogen) together with natural birch and pine regeneration. As a result of such action a large number of herbaceous plants that inhabited taiga spruce/deciduous communities in the past but cannot grow under the spruce canopy would be able to establish themselves.

Age of stands

Estimations of the absolute ages of individual trees have shown that old stands are widespread within the study area. Both pine and spruce have a maximum possible age which depends on climate, latitude, soil conditions, etc. of the given location. Approximately 595 year old pine trees and 375 year old spruce trees have been reported within the study area. Available data suggest that taiga areas with a 300–500 year generation cycle are reforested very slowly. The protection of such unique forest communities is of the utmost importance from the points of view of both nature conservation and science.

Rare plant species

In the course of the study habitats of the following rare species were identified:

Red Data Book of Karelia (1995)

1. *Ranunculus aquatilis* var. *diffusus* With. In a creek flowing into Lake Kalivojärvi, comp. 17.
2. *Lobaria pulmonaria* (L.) Hoffm. (photo 1). Epiphytic lichen commonly growing on old goat willow trees, less commonly on aspen trees. Occurs throughout the entire territory.
3. *Lobelia dortmanna* L. Encountered in the shallow zones of Lake Okattijärvi, comp. 2.

Remarkable species

1. *Carex buxbaumii* Wahl.
2. *Convallaria majalis* L.
3. *Dryopteris cristata* (L.) A. Gray
4. *Huperzia selago* (L.) Schrank et Mart.
5. *Matteuccia struthiopteris* (L.) Tod.
6. *Melica nutans* L.
7. *Milium effusum* L.
8. *Prunus padus* L.
9. *Paris quadrifolia* L.
10. *Platanthera bifolia* (L.) Rich.
11. *Potamogeton berchtoldii* Fieb.
12. *Pyrola chlorantha* Sw.
13. *Pyrola media* Sw.
14. *Rosa majalis* Herm.
15. *Subularia aquatica* L.
16. *Utricularia minor* L.

Proposals for the optimisation of the Kostamus Nature Reserve area

A proposal has been made to attach to the reserve the compartments 1–4, 17–20, 28–31, 46–49, 64–69 and 85–86 of the Kiimasjärvi Forest Estate, together with a strip of land adjoining the state border (Fig. 2). The area to be attached includes old, slightly disturbed forests which exhibit remarkable and protected species. Within the present boundaries of the Kostamus Nature Reserve 80–160 years old post–fire pine stands are common (Gromtsev & Shelehov 1997) Expansion of the reserve will lead to an increase in the proportion of forest communities at more advanced stages of post–fire succession.

In order to develop methods for increasing biodiversity and to test ecological and economic forestry methods, it is desirable to establish an experimental biosphere site within the Kostamus Nature Reserve. This site will occupy compartments 70–78, and 87–88 of the Kiimasjärvi Forest Estate and compartments 1–11 and 19–30 of the Saarenpää Forest Estate (Mujejärvi Forestry Farm).

The protection zone could cover compartments 5, 139, 145, 141, 142, 146, 147 and 339 at the northern boundary of the reserve and compartments 5, 21, 32 and 50 of the Kiimasjärvi Forest Estate at the eastern boundary.

The reserve is divided from north to south by a barbed wire fence which constitutes a physically insurmountable barrier to large animals such as wild forest reindeer. This problem can be resolved by making gates for migrating animals or removing the fence from the reserve.

Grounds for the expansion of the Kostamus Nature Reserve: an assessment based on landscape, ecological and silvicultural criteria

A. N. Gromtsev

Landscape ecological studies began in Kostamus Nature Reserve in 1992. Various ecological studies and assessments have been conducted on the basis of the landscape characterisation of particular areas. Results of these studies have been recently published (Gromtsev et al. 1997; Gromtsev & Shelehov 1997).

Comprehensive description of the structure and dynamics of ecosystems in relation to topographic characteristics, soil–forming rocks, the extent of paludification of the study area, and other landscape features, gives the reader a clear idea as to the basic characteristics of the animate nature within the area in terms of its relation to existing physico–geographic conditions.

Protected nature territories (PNT) with primeval forests in North Karelia: present situation and outlook for the future.

North Karelia presently possesses the Paanajärvi National Park (103 000 ha) and the Kostamus Nature Reserve (47 000 ha). The decision to establish the Kalevala National Park (about 100 000 ha) has been approved. The ecological feasibility study for the Olonyeostrovsky and Keret nature parks or national parks that will together cover an area of at least 80 000 ha on the White Sea coast is now in progress. Thus the total area of protected territories lying within the districts of Louhi, Kalevala, Kemi, and Kostamus districts will be approximately 330 000 ha. Group 1 type forests, e.g. those inhabiting water protection zones extending along the White Sea coast, those of the Pääjärvi – Tuoppajärvi lake–river system, the Kuittijärvi system etc., where hunting is strictly restricted, are not included. These taiga terri-

tories form 'ecological corridors' between specially protected territories and cover about 10 % of the total area of the region. No region of comparable size in West Europe (including Fennoscandia) contains such a large body of nature conservation areas.

A similar situation is observed in South Karelia where a system of PNTs, with the Vodlajärvi National Park (500 000 ha) as a key link, is being formed from the White Sea coast to the border of Vologda Region.

Existing and planned PNTs: are they representative and adequate?

The system of PNTs now being created in North Karelia includes:

1) taiga landscapes, such as primeval fire–generated pine taiga, most typical of East Fennoscandia (planned Kalevala NP and Kostamus Nature Reserve);

2) taiga landscapes that are rare in Karelia such as primeval spruce taiga growing under highly paludified coastal plain conditions (planned Olenyeostrovsky Park);

3) unique taiga landscapes, e.g. primeval low mountain spruce taiga (Paanajärvi National Park).

Thus, the PNTs that are now being established in North Karelia display a broad spectrum of landscape and sub–landscape ranking taiga ecosystems over a total area of at least 330 000 ha (about 8 % of the forested area of the entire northern taiga sub–zone within Karelia). Taking into account certain group 1 type forests which have retained their natural state, the percentage of protected fragments of taiga landscapes is expected to exceed 10 %. According to some preliminary estimates, including those of Western experts, this index is optimal from both the ecological and economic points of view. Furthermore, the protection of natural ecosystems within the region (over a total area of approximately 100 000 ha) on a geographic landscape level will provide for the stable existence of associated complexes, endangered and rare species as well as animals and plants sensitive to human activities.

Proposals for expansion of the Kostamus Nature Reserve

Based on the results of study and analysis of the present state and prospects of PNTs we suggest the following:

1) Extension of the Kostamus Nature Reserve southward, westward or eastward on the basis of landscape or silvicultural criteria is not justified. The most typical northern taiga complexes are now already protected in the Kostamus Nature Reserve and will be protected in the Kalevala and Tuulijärvi National Parks to be established over an area of some 190 000 ha. Protection zones, 0,5–1,0 km in width (according to the type of landscape), must be established in the above zones along the boundary of the reserve;

2) Hunting within these protection zones should be restricted. Clear felling, mining operations and other activities must be prohibited;

3) There are grounds for extending the Kostamus Nature Reserve in compartments 85–89 and 107–111 of the Latvajärvi Forest Estate.

These are as follows:

a) this type of landscape is not represented in any of the existing protected areas established in the northern taiga sub–zone of Karelia;

b) most of the area in question is highly paludified and clear felling on small flat mineral 'islands' would have a harmful effect on the environment. As a result, natural paludification would be accelerated and the habitats of typical taiga animal and plant species would be destroyed.

c) the economic damage caused by the withdrawal of forest resources would be fairly small because the forest cover displays an 'insular' pattern (low timber reserves per unit area).

Mire studies as part of the project for the optimisation of the Kostamus Nature Reserve area

O. L. Kuznetsov

The Kostamus Nature Reserve is located in the centre of the West Karelian Uplands. The terrain is fairly rugged and there exist a variety of northern taiga forest, mire and lake ecosystems. According to the mire demarcation plan of Karelia (Yelina et al. 1984), the reserve lies in the aapa mire zone of the West Karelian Uplands. 15–30 % of this upland landscape is accounted for by mires, with small (100–200 ha) mires commonly interconnecting to form complex systems. Mesotrophic string–flark aapa mires with grass flarks and *Sphagnum* strings (Karelian string aapa type) are widespread along with mesotrophic *Sphagnum* and ombrotrophic (raised) *Sphagnum* ridge–hollow and pine – dwarf shrub–*Sphagnum* bogs that form complex mire systems. The above types of mires are unequally represented in the Kostamus Nature Reserve (Yelina & Kuznetsov 1977, Kolomytsev & Kuznetsov 1997).

Two landscapes differing in topographic structure and extent of paludification have been identified in the reserve (Gromtsev et al. 1997). Small mires varying in size from several hectares to 50–100 ha, dominated by mesotrophic grass – *Sphagnum*, ombrotrophic dwarf shrub – *Sphagnum* and pine – dwarf shrub – *Sphagnum* types, occur over most of the reserve in the moderately paludified type 14 landscape. In such areas there are practically no typical aapa mires with well developed string–flark microrelief and specific flora.

The northern part of the reserve between Akonlahti Bay and Kamalahti Bay and the zone north of the Kostamus–Lyttä highway are occupied by an extensively paludified landscape containing a complex of glacial deposits (type 13 g). Extensive mire systems account for 50–60 % of such areas. Paludified forests also cover large areas. This landscape lies on the Baltic Sea – White Sea watershed. It exhibits a slightly rugged topography, low hills with a thin layer of till raised only a few metres above adjacent mire systems. Complex mire systems are dominated by poor meso–oligotrophic grass – *Sphagnum* and ombrotrophic *Sphagnum* ridge–hollow mires restricted to wide central basins. Most of these mires originated as lakes (Kolomytsev & Kuznetsov 1997). String–flark aapa mires are common in basins supplied with considerable quantities of ground water. Narrow and shallow ravines between often steeply sloping mineral islands are occupied by oligotrophic or meso–oligotrophic pine – dwarf shrub – *Sphagnum* communities. Mesotrophic grass and grass – *Sphagnum* coenoses evolve on hill slopes and between forest islands along their runoff lines, ground water wedging out considerably. However, because the bedrock is poor and the ground water weakly mineralised, eutrophic and

calciphilous species are absent from areas where high pressure ground water is discharged (i.e. springs). The mire flora of the area is generally poor, but some species were observed close to their distribution boundaries (Kravchenko 1997). Because most of the type 13 g landscape lies outside the reserve the diversity of mire ecosystems is not represented in the reserve. To retain a typical spectrum of North Karelian forest – mire complexes near Kostamus the reserve area should be optimised and extended northwards. A complex wildlife area should be established in compartments 85–89 and 107–111 of the Latvajärvi Forest Estate to prevent felling, the construction of cottages and the drainage of mires for fuel peat extraction. Collecting of berries and mushrooms should be allowed. Routes with parking places and paths of environmental interest should be established.

In 1993 mire systems were studied in compartments 85–89 and 107–111 by the Sevzapgeologia Peat Expedition (St. Petersburg) in order to estimate their peat resources for possible fuel peat extraction. They were all found to be suitable for that purpose and approved as a source of fuel for the Kostamus heat power plant. The mires are up to five metres deep. All types (eutrophic,mesotrophic, mixed and ombrotrophic) of peat deposits were identified. Peat reserves were calculated and the properties of the peat were assessed. Most sites could be easily drained. Peat exploitation remains a threat for these mires as long as they are not protected.

In 1980 and 1998 the Laboratory of Mire Ecosystems of the Institute of Biology, Karelian Centre, Russian Academy of Sciences studied some of these mires and established their nature conservation value.

Remarkable mires with the estimation of their conservation value

Vodorazdelnoye Mire is located in compartments 107 and 85. It is a complex system covering an area of approximately 400 ha and incorporates a number of individual mires separated from each other by forested mineral islets. There are three residual ponds within the mire. Vodorazdelnoye Mire lies at an altitude of 250–255 metres a.s.l. It flows west into the Baltic Sea basin through Lake Kivijärvi and east into the White Sea basin through Lake Kiitehenjärvi. The vegetation cover of this mire system is dominated by meso–oligotrophic cottongrass – *Scheuchzeria* – *Sphagnum* coenoses, *Sphagnum papillosum, S. balticum, S. majus* and *S. compactum* prevailing in the ground layer. To the west of the elongate pond lies a fairly swampy aapa complex with large flarks. Patches and strips of sedge – *Sphagnum* communities consisting of *Carex rostrata* that mark the wedging–out of poor ground water and its flow direction often occur on the mire. The mire margin and narrow tongues between the mineral islets are occupied by ombrotrophic pine – dwarf shrub – cloudberry – *Sphagnum* coenoses that produce high quality cloudberries. The cloudberry yield here was notably high in 1998. Large cottongrass – *Sphagnum* communities exist in this mire system. Ground layer is dominated by *Sphagnum compactum*, a northern sub–arctic species which commonly occurs in the form of small sods among other *Sphagnum* moss species.

Lying in compartments 108-109 and covering an area of some 300 ha, Provalnoye Mire is a system comprising several types of mires: a string–flark aapa type, an ombrotrophic *Sphagnum* string–flark type and a pine – dwarf shrub – *Sphagnum* type. The mire incorporates a few small residual ponds. It flows north into Lake Kivijärvi and south into Lake Kiitehenjärvi which is located in the reserve. It contains approximately four metres thick peat. Both ombrotrophic and mesotrophic peat deposit types occur. The ombrotrophic peat layer in the raised bog is up to two metres thick, which is uncommon in North Karelia. The raised stage of mire evolution recorded here is mostly young and the ombrotrophic peat layer is typically 1,0 to 1,5 metres thick. *Scheuchzeria* – sedge – *Sphagnum* coenoses with *Sphagnum pulchrum* dominating in the moss storey are of considerable interest. In Karelia *Sphag-*

num pulchrum reaches the eastern margin of its distribution area because it is restricted to areas with a humid marine climate. In the vicinity of Kostamus it often occurs as patches among other *Sphagnum* mosses. On this particular mire, *Sphagnum pulchrum* forms communities on low strings and flarks margins in aapa complexes. This mire is a valuable recreation area as well as a source of cranberries and cloudberries.

Situated in compartment 109, Zubrovkovoye Mire is unique throughout the whole of North Karelia. It covers an area about two hectares and is located on a steep hill sloping down toward a creek which connects two small ponds. A creek flows out of the western pond into Lake Kivilampi. The northern bank of the creek rises up some 4–5 metres. Relatively highly mineralised ground water wedges out at this point and as a consequence the flora of the mire is both specific and diverse. The meso–eutrophic community along the creek lies under water during the spring floods. It consists of several *Salix* species, *Potentilla palustris, Sphagnum obtusum, S. teres, Calliergon cordifolium* and *Warnstorfia exannulata*. Further up the slope a highly unique herb grass – *Sphagnum* cenosis occurs, consisting of species indicative of spring influence: *Festuca rubra, Equisetum palustre, Carex appropinquata, C. diandra, Hierochloe arctica, Crepis paludosa, Epilobium palustre, Parnassia palustris, Sphagnum warnstorfii* and *Paludella squarrosa*. Here exist also a number of species characteristic of lush forest habits supplied by running water. These include *Filipendula ulmaria, Paris quadrifolia* and *Melica nutans*. This cenosis incorporates two sedge species, *Carex appropinquata* and *C. diandra*, that have not been encountered in the Kostamus Nature Reserve (Kravchenko 1997). *C. appropinquata* is most rare. Its closest habitats elsewhere in North Karelia are located in the Paanajärvi National Park and near Yuma, in Kemi district. It is also rare in the adjacent areas of Finland. *Sphagnum denticulatum*, a species which is seldom encountered in Karelia and is listed in the Red Data Book of Karelia (1995), was identified in a flark in this mire and at the north–western end of the eastern pond. In Karelia this western amphiatlantic species reaches the eastern boundary of its distribution. It has only been reported at three sites along the Russian–Finnish border. Its extent on this mire is exceedingly small (1–2 m^2).

Farther north, also overlying the boundary of compartments cutting strip 109 and 110 is a meso–oligotrophic pine – dwarf shrub – sedge – *Sphagnum* mire, located on a slope. It has several narrow forks extending between mineral islands and raised sites where high cloudberry yields have been recorded.

Of very great scientific and nature conservation value is the aapa mire situated in the north–eastern corner of compartment 109 and part of compartment 110. There are several secondary pools in the mire. The mire has been given the name Multilampisuo. It has an area of some 120 ha and is part of a complex system located farther east in compartment 110. Multilampisuo mire drains northward along a creek via the eastern pond into Kivilampi Pond and then along a southward creek flowing at the western mire margin into Lake Kiitehenjärvi. There is a primary residual clear–water pond, approximately 20 x 40 metres in extent, from which a creek flows north–eastward into the large eastern pond. Other ponds are secondary pools which form part of a string–pools aapa complex. Altogether there are about ten ponds in the area. They contain numerous round hummocks made up of *Sphagnum papillosum* and *S. pulchrum* along with patches of sedges (*Carex rostrata and C. limosa)* and *Menyanthes trifoliata*. Over the past two to three thousand years no new peat has been deposited in these ponds. Instead, peat which had formed earlier is in the process of decomposition (Kuznetsov 1986). The ponds are separated by two to five metre wide grass – *Sphagnum* strings which actively grow upwards, so increasing the degree of pond water stagnation. Such pools are formed gradually by the decomposition of grasses in grassy flarks. This process can be

observed in its various stages on Multilampisuo Mire. Small grass flarks and grass – *Sphagnum* communities growing on string margins indicate that strings replaced grass coenoses. Communities with *Sphagnum pulchrum*, very uncommon in other parts of Karelia, are widespread on this mire as well as on Provalnoye Mire. Water flows south–westward from the string–pool complex into the creek. Thus, there is a watershed at the centre of the mire. The southern part of the mire is occupied by oligotrophic cottongrass – *Sphagnum* and *Scheuchzeria* – *Sphagnum* communities whereas sedge – *Sphagnum* coenoses are abundant along the creek. Of great interest is a large pond located in compartment 109 to the west of the mire. The creek which drains the mire flows out from it. The water level in the pond, which is presently some 3–4 metres below the mire surface, must have fallen markedly over the past millenium. The pond is now surrounded by a wide strip of grass (sedge, horsetail) coenoses formed on the exposed peripheral area of the pond–bed.

The scenically attractive Multilampisuo Mire contains mineral islands from which one can view the entire mire and its surroundings. The mire is easily accessed from the highway which lies only 3 km away. Tourist routes and nature trails can be established in compartment strip 109 – 110 for those wishing to visit the various types of mires, ponds and forests. People may also come to pick berries and mushrooms in the area.

Fig. 2. A view of Multilampisuo mire.

Assessment of the potential protection value of the area

The forest–mire complexes and numerous ponds located in compartments 85–89 and 107–111 of the Latvajärvi Forest Estate are of great value and should be protected. If this territory is officially granted a complex wildlife area status, it would become available to the population of Kostamus for environmental education and restricted recreational purposes.

Mammals inhabiting the reserve and adjacent areas

S. V. Tarhov

Mammals

Data available in relevant literature (Danilov 1975, Isakov 1939, Marvin 1948, Siivonen, 1979, Red Data Book of Karelia 1995, Pozdnyakov 1997) and recent data obtained by the staff of the Kostamus Nature Reserve during the period 1993–1998 show that 39 mammal species (Table 7), 12 of which are listed in the Red Data Book of Karelia (1995), inhabit the reserve and its environs.

Sorex minutissimus Zimm. inhabits greenmoss and lichen pine stands. *Sorex isodon* Turov was commonly captured north of the river Kivijoki, but was seldom encountered south of the river. This species lives typically in the least disturbed creek spruce stands but is occasionally found in pine stands and even in the city. The populations of both species are extremely low.

In 1989 – 1990 Erinaceus europaeus were observed in the Kostamus area. On 21st September 1990 a hedgehog was caught by frontier guards near the southern reserve boundary, 4 km from the nearest human dwelling and 40 km from the city. It is not clear, however, why the hedgehog has penetrated so far north.

Although common, the forest lemming is seldom encountered. During periods when its population was low it typically inhabited over–mature spruce stands. However, during high reproduction periods (1987–1989 and 1996–1997) these animals became ubiquitous. During these times, dead lemmings were found on mink paths near bodies of water, in the stomachs of pike and in the city.

The habitats of the flying squirrel were located from faeces discovered by a Moscow State University expedition in the middle of River Kivijoki (Report of GD, MSU, 1989) and a visual encounter in 1987 on River Kivijoki.

Black polecats are very rare in the Kostomuksha area. Two to three polecats are killed by hunters every year near Lakes Luvajärvi and Nuokkijärvi (Pozdnyakov 1997), north of the polecat's generally accepted distribution boundary (Danilov & Tumanov 1976). The European mink has not been encountered in the study area. The disappearance of this species seems to have been caused by the colonisation of the region by the American mink which competed with and successfully displaced the aboriginal species. The occurrence of badger, a rare animal in North Karelia, has been corroborated (Danilov & Tumanov 1970). In 1987 an uninhabited burrow was found by an MSU expedition in compartment 107 of the Latvajärvi Forest Estate near the northern boundary of the reserve. In July 1993 a young female badger was killed in compartment 126 by dogs that were running wild.

Table 7. List of mammals inhabiting the Kostamus Nature Reserve and the territory to be attached. Symbols: ? species probably occurs, + species identified, – species not been reliably identified or thoroughly searched (Pozdnyakov 1997).

No.	Species	Occurrence in reserve	Occurrence in adjacent areas	Category of rarity in the Red Book Of Karelia
	INSECTIVORA			
1.	Erinaceus europaeus L.	+	+	3
2.	Sorex araneus L.	+	+	
3.	S. caecutiens Laxm.	+	+	
4.	S. minutus L.	+	+	
5.	S. minutissimus Zimm.	+	?	3
6.	S. isodon Turov	+	+	4
7.	Neomys fodiens Penn.	+	+	
	CHIROPTERA			
8.	Eptesicus nilssoni Keys. Et Blas.	+	+	
	Order LAGOMORPHA			
9.	Lepus timidus L.	+	+	
	RODENTIA			
10.	Pteromys volans L.	+	?	3
11.	Sciurus vulgaris L.	+	+	
12.	Castor canadensis Kuhl.	+	+	
13.	Mus musculus L.	–	–	
14.	Rattus norvegicus Berc.	+	–	
15.	Ondatra zibethica L.	+	+	
16.	Arvicola terrestris L.	?	+	
17.	Microtus agrestis L.	+	+	
18.	M. oeconomus Pall.	+	?	
19.	Clethrionomys glareolus Schreb.	+	+	
20.	Cl. rutilus Pall.	+	?	
21.	Cl. rufocanus Sund.	+	?	
22.	Myopus schisticolor Liij.	+	+	4
	CARNIVORA			
23.	Lutra lutra L.	+	+	2 (3)
24.	Meles meles L.	+	+	4
25.	Gulo gulo L.	+	+	2
26.	Martes martes L.	+	+	
27.	Mustels nivalis L.	+	+	4
28.	M. erminea L.	+	+	
29.	M. lutreola L.	–	–	1
30.	M. vison Schreb.	+	+	
31.	M. putorius L.	?	+	4
32.	Ursus arctos L.	+	+	
33.	Canis lupus L.	+	+	
34.	Vulpes vulpes L.	+	+	
35.	Nyctreutes procynoides Gray.	+	?	
36.	Felix Lynx L.	+	+	
	ARTIODACTYLA			
37.	Sus scrofa L.	–	+	
38.	Rangifer tarandus L.	+	+	4
39.	Capreolus capreolus L.	+	+	3
40.	Alces alces L.	+	+	

Forest reindeer and elk are common but not prolific. Forest reindeer have summer habitats in the reserve. Groups of at least five animals had often been observed between March and December up until 1990, and rutting reindeer were seen near Lake Kalivojärvi in late September/October 1987–1988. Nowadays, however, it is more common to meet individuals and groups of not more than three animals. The barbed wire fence erected in the reserve must have disturbed the natural migration and consequently this species has become less common. The fence constitutes an insurmountable barrier for forest reindeer and young elk that inhabit the area adjacent to it in summer time and move to Finland in October.

In 1987 and 1988 individuals and groups of boars were reported in compartments 126–127 of the Latvajärvi Forest Estate near Kostamus and Kontokki. In 1990 – 1992 roe deer were seen to enter the reserve from Finland where a stable population of this species has existed since 1971.

The structure of the mammal fauna occurring in the Kostamus Nature Reserve is typical of northern boreal forests. Its fairly poor species composition and low population levels are characteristic. The penetration of southern forest and subarctic fauna is obviously due to changes in the landscape of the Kostamus area caused by human activities. Considering that the habitats of some big animals, such as the brown bear, wolf, wolverine, reindeer, otter etc., often lie outside the reserve, the area of the reserve should be extended in order to improve the effectiveness of its protective status.

Grounds for designating the Kostamus experimental stratigraphic site as a specially protected geological site

V. Y. Gorkovets

An experimental stratigraphic site was established as a model of Late Archean supracrustal strata on the basis of studies conducted by the Institute of Geology (Karelian Research Centre, Russian Academy of Sciences) in the Kostamus iron deposit area.

This stratigraphically important site of Lopian (Late Archean) rocks was recognised as a stratotype by the Interdepartmental Stratigraphic Committee of Russia at the second All–Union meeting on the subdivision of the Precambrian aeon, held in Ufa in 1990.

Site description

The Lopian site consists of three zones. Zone 1 lies 10 km north–west of Kostamus, zone 2 is located in the southern part of the Kostamus iron deposit and zone 3 coincides with the central pit of the Kostamus iron deposit.

This geological demonstration site is of significant interest to both Russian and foreign geologists. The site as a whole (Lake Niemijärvi – Taloveis hill, Kostamus deposit) incorporates one particular area of about 30 square kilometres (8 x 4 km) which contains a number of unique geological units such as centres of ultramafic (komatiitic), mafic (basaltic) and felsic (rhyodacitic) volcanism surrounded by rocks that retain primary textural characteristics (relics of textures). Established relationships exist between these rocks. There are visible boundaries (contacts) between the stratigraphic units of series and suites, an Archean areal crust of chemical weathering recognised for the first time in Karelia, Archean units composed of meta–sedimentary rocks and various genetic types of cherty–iron rocks (iron

formation) associated with terrigeneous sedimentary rocks, volcanics of metabasalt composition and volcano–sedimentary rocks of rhyodacite composition. Metamorphogenic iron ore is also in evidence.

Lopian deposits in this area were repeatedly metamorphosed into green schist and amphibolite grade. As a result metamorphic zones arose and today extend from the central part of the Kostamus synclinorium toward its flank. These zones vary from epidote–amphibolite facies with relics of green schist facies to amphibolite facies. Migmatisation and granitisation processes are apparent in the amphibolite–facies zone. Fe–Ca–Mg metasomatic processes are common.

Structural studies in the area have shown that Lopian iron ore–schist units were repeatedly deformed. As a result folds, schistosity, lineation, systems of ruptures, etc. were formed.

In order to preserve the above geological localities which are of significant valuable earth scientists a valuable site status is sought for the Lake Niemijärvi – Taloveis hill area. The site could be protected by the Kostamus City Council in collaboration with the Kostamus ore–dressing plant (KODP). This area of great scientific and educational value could become a venue for ecological excursions.

Present condition of the locality

Natural bedrock exposures were cleaned along a logging track over a distance of 8–10 km and in an adjacent 100–200 metre wide strip, and hundreds of artificial outcrops were manually exposed. They are all in good condition but fallen leaves and needles need to be regularly removed. Unfortunately, exposed rocks, particularly ultramafic types (komatiites), become rapidly overgrown by lichen and moss.

In the central pit mined by the Kostamus ore–dressing plant, sites of geological interest, such as a crust of chemical weathering, polymictic conglomerates, lamproites containing diamonds, etc., are not always exposed because of mining operations.

Protection Code of Management

A code of management should be announced in order to protect the Kostamus Experimental Stratigraphic Site (with the exception of the pit mined by the Kostamus ore–dressing plant) in accordance with Clause 9 on nature conservation in Russia. In keeping with the Provision on state–owned areas of environmental value as approved on 27th April 1981 by Gosplan of the USSR and SCST, any types of activities which cause damage to the area are prohibited.

A code of management should be established for the Lake Niemijärvi – Taloveis hill area as well as for the southern part of the Kostamus deposit.

Prohibited activities:

1. Geological work and research which may destroy or damage sites of geological value.
2. All construction activity.
3. Off–road traffic.
4. Dumping at valuable sites.
5. Mining of commercial minerals including construction materials.

Permitted activities:

1. Collecting berries and mushrooms; fishing.
2. Access for KODP vehicles on main roads.
3. Educational activities.
4. Non–destructive research and field surveys.

The Institute of Geology (Karelian Research Centre, Russian Academy of Sciences) should request the KODP Administration to clean the site displaying Archean crust of chemical weathering in the central part of the southern and south–western flank of the central pit.

This work should be agreed upon together with the Institute of Geology. The mining of iron ore will not be affected because this site is located at the periphery of the pit, outside the ore seams.

If the above steps are taken and a code of management for the conservation of the area is announced, field studies may be arranged for both Russian and foreign scientists at this geologically valuable location with its unique Lopian sites.

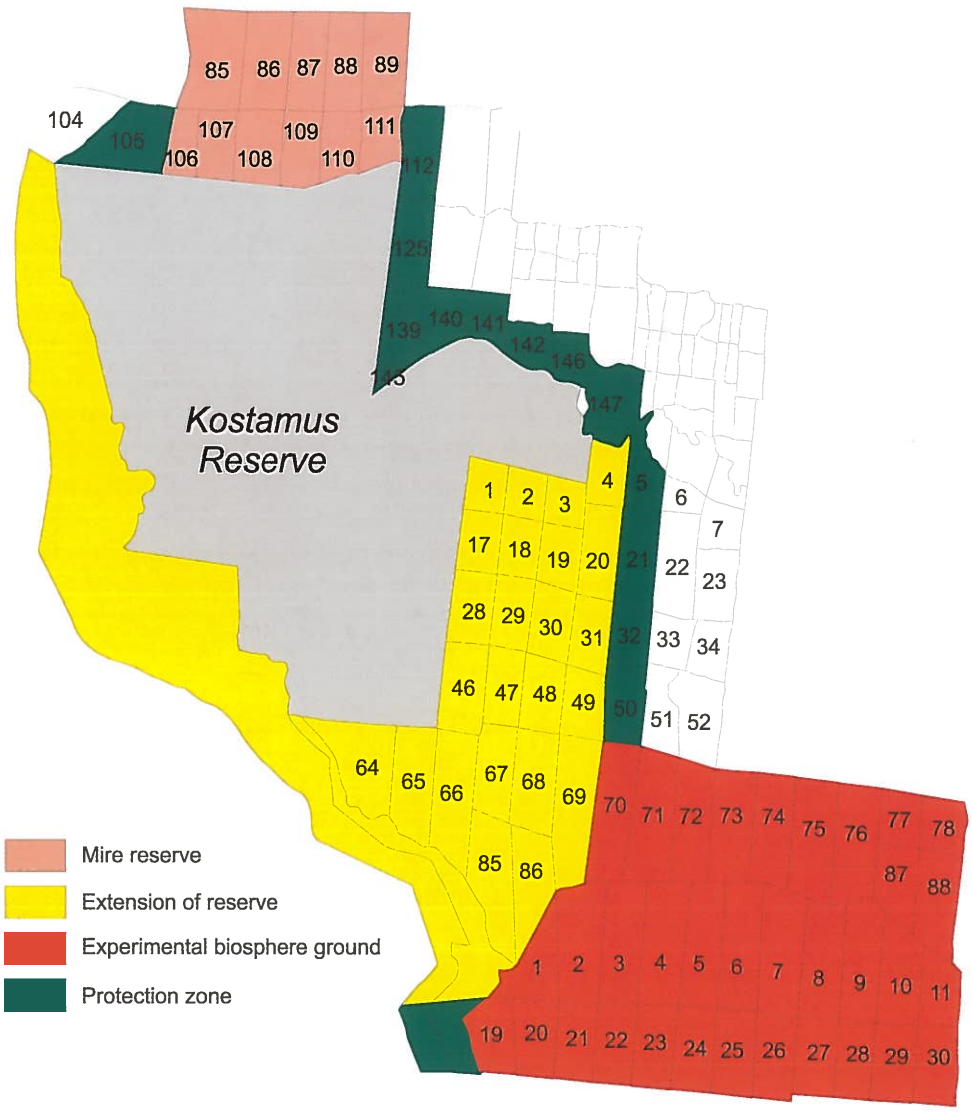

Fig. 3. A proposal for the extension of Kostamus Zapovednik.

Conclusions

S. V. Tarhov

The Kostamus Nature Reserve should be extended and a protection zone, an experimental biosphere site, a mire wildlife area, and sites of geological value should be established in two stages.

In stage 1 a protection zone will be established around the reserve in the territories governed by Kostamus City Council in compartments 105–112, 125–126, 139–147, and 325–329 of the Latvajärvi Forest Estate, and in compartment 504 of the Kostamus Forest Estate as well as along the Finnish–Russian border as far as compartment 120 of the Kiimasjärvi Forest Estate (Table 8, Fig. 3.). Also a special frontier zone will be established in Mujejärvi district in compartments 1–3, 17, 28, 46, 64–66, and 120–122 of the Kiimasjärvi Forest Estate (Table 9, Fig. 3.).

During stage 2 the boundaries of the territories discussed will be agreed upon together with relevant bodies. As a consequence, an experimental biosphere site may be established in Mujejärvi district in compartments 70–78 and 87–88 of the Kiimasjärvi Forest Estate and compartments 1–11 and 19–30 of the Saarenpää Forest Estate (Mujejärvi Forestry Farm). At the same time the mire wildlife area and sites of geological value will be delineated and the reserve extended in the territory governed by Kostamus City Council.

Table 8.

Distribution of compartments to be incorporated in a protection zone in Kostamus and Latvajärvi Forest Estates on the basis of forest categories

Land user	Compartment number	Total area, ha			Forest area, ha
		Total	Group I	Group III	
Latvajärvi Forest Estate	106-113, 125, 126, 139-141, 145-147	15553,1	1097	14456,1	9665
Kostamus Forest Estate	504	953,4	285,4	668	670,4
Total		16506,5	1382,4	15124,1	10335,4
Special frontier zone, Latvajärvi Forest Estate		13901	-	13901	*
Total for protection zone		30497,5	1382,4	29025,1	20000,4

* - data on forest fund are not available

Table 9.

Distribution of compartments to be incorporated into a protection zone surrounding the Kostamus Nature Reserve on the basis of forest categories

Land user	Compartment Number	Total area, ha			Forest area, ha
		Total	Group I	Group 3	
Kiimasjärvi Forest Estate	1-3, 17, 28, 46,64-66	9449	-	9449	6018
Special frontier zone	120-122	980		980	617
TOTAL		10429		10429	6635

References

Danilov, P. I. 1975: Distribution and populations of hoofed animals in Karelia. – Hoofed fauna of the USSR. Moscow. 80 – 82 pp (In Russian).

Danilov, P. I. & Tumanov, I. P. 1970: Badgers in Northwest Russia – Amateur and commercial hunting. 3: 16–17 (In Russian).

Danilov, P. I. & Tumanov, I. P. 1976: Animals of the marten family in Northwest USSR. – Nauka, Leningrad. 255 pp (In Russian).

Elina, G. A. & Kuznetsov, O. L. 1977: Mire types, their usage and protection. – In: Biske, G. S., I. M. Nesterenko & O. I. Potapova (eds.). Biological resources of Kostomuksha region, ways of usage and protection: 5–23. Petrozavodsk (In Russian).

Elina, G. A., Kuznetsov, O. L. & Maksimov, A. I. 1984: Structural–functional organisation and dynamics of mire ecosystems in Karelia. – Nauka, Leningrad. 128 pp.

Gromtsev, A. N., Kolomytsev, V. A. & Shelekhov, A. M. 1997: The landscapes of the Kostomuksha Nature Reserve. – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.) Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve. 124: 31–42 Helsinki.

Gromtsev, A. N. & Shelekhov, A. M. 1997: Forests in the Kostomuksha Nature Reserve: natural characteristics and dynamic pattern. – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.) Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve. 124: 43–51 Helsinki.

Isakov, Y. A. 1939: Mammal fauna in North and Middle Karelia – Bull. MOIP. Biology Section. 48 (2-3): 37–50 (In Russian).

Kolomytsev, V. A. & Kuznetsov, O. L. 1997: Mires and paludified forests os the Kostomuksha Nature Reserve. – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.) Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve. 124: 53–62 Helsinki.

Kuznetsov, O. L. 1986: The structure and age of ridge–hollow aapa mire complexes. – Univ. Joensuu Publications of Karelian Institute 79: 73–79.

Kravchenko, A. V. 1997: Vascular plants of the Kostomuksha Nature Reserve. – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.) Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve. 124: 87–90 Helsinki.

Marvin, M. L. 1948: Mammals in the Karelian–Finnish SSR – Izv. Karelo–Finskoi nauch.–issl. bazy AN SSSR. 1:103–108 (In Russian).

Pozdnyakov, S. A. 1997: Notes on the mammal fauna of the Kostomuksha Nature Reserve – In: Lindholm, T., Heikkilä, R. & Heikkilä, M. (eds.) Ecosystems, fauna and flora of the Finnish–Russian Nature Reserve: 124: 195–202 Helsinki.

Red Data Book of Karelia. 1995: – Petrozavodsk. 286 pp (In Russian).

Red Data Book of RSFSR. Plants. 1988: – Moscow. 590 pp. (In Russian).

Siivonen, L. 1979: Mammals of North Europe. – Moscow. 231 pp (In Russian).

Documentation page

Publisher	North Ostrobothnia Regional Environment Centre	Date March 2000
Author(s)	Raimo Heikkilä, Hanna Heikkilä, Aleksei Polevoi & Evgeni Yakovlev (eds.)	
Title of publication	Biodiversity of old-growth forests and its conservation in northwestern Russia	
Parts of publication/ other project publications		
Abstract	The five articles of this publication deal with the biodiversity of northwestern Karelian Republic along the Finnish boundary and needs for its conservation. The studies cover geology and geomorphology of the area, mosaic forest and mire ecosystems as well as flora of vascular plants, lichens, bryophytes and hepatics, and fauna of insects. Numerous threatened and new species for Karelia were found, and also some plant communities were not described earlier. On the basis of the studies, proposals for the extension of Kostamus strict nature reserve, boundaries of the proposed Kalevala national park as well as establishing some new small nature reserves were made. The results show that present nature reserves and conservation plans do not adequately guarantee the preservation of biodiversity in the region.	
Keywords	biodiversity, nature protection, old-growth forests, primeval forets, Russian Karelia, national park, nature reserve, forest ecosystem, mire ecosystem, vegetation, vascular plants, lichens, hepatic flora, bryoflora, entomofauna, insect species, geology, geomorphology, threatened and rare species	
Publication series and number	Regional Environmental Publications 158	
Theme of publication		
Project name and number, if any	"Protection of old-growth forests in Kuusamo area", EU LIFE Nature-project (B4-3200/96/543)	
Financier/ commissioner	EU/LIFE Nature, North Ostrobothnia Regional Environment Centre	
Project organization		
	ISSN 1238-8610	ISBN 952-11-0700-6
	No. of pages 206	Language Finnish
	Restrictions Public	Price 150 Fmk
For sale at/ distributor	North Ostrobothnia Regional Environment Centre phone +358 8 315 8300 fax +358 8 315 8305	Edita Ltd phone +358 9 5660266 fax +358 9 566 0380
Financier of publication	EU/LIFE Nature, North Ostrobothnia Regional Environment Centre	
Printing place and year	Multiprint, Oulu 2000	

Kuvailulehti

Julkaisija	Pohjois-Pohjanmaan ympäristökeskus	Julkaisuaika Maaliskuu 2000
Tekijä(t)	Raimo Heikkilä, Hanna Heikkilä, Aleksei Polevoi & Evgeni Yakovlev (toim.)	
Julkaisun nimi	Biodiversity of old-growth forests and its conservation in northwestern Russia	
Julkaisun osat/ muut saman projektin tuottamat julkaisut		
Tiivistelmä	Kokoomajulkaisun viisi artikkelia käsittelevät Venäjän Karjalan Suomen vastaisen rajaseudun luonnon monimuotoisuutta ja sen suojelutarpeita. Tutkimuksissa käsitellään alueen geologiaa ja geomorfologiaa, putkilokasvi-, jäkälä-, sammal-, maksasammal- ja hyönteislajistoa sekä metsä- ja suoekosysteemien mosaiikkia. Alueelta löytyi lukuisia Karjalassa uhanalaisia ja Karjalalle uusia eläin- ja kasvilajeja. Myös eräät kasviyhdyskunnat olivat aiemmin Karjalassa tuntemattomia. Tutkimusten perusteella on tehty ehdotuksia Kostamuksen luonnonsuojelualueen laajentamiseksi, esitetyn Kalevala-kansallispuiston rajaukseksi sekä uusien pienten luonnonsuojelualueiden perustamiseksi. Tutkimukset osoittavat, että alueen monimuotoisuuden säilyttämiseksi tähänastiset suojelualueet ja suojelusuunnitelmat eivät ole täysin riittäviä.	
Asiasanat	luonnon monimuotoisuus, luonnonsuojelu, vanhat metsät, Venäjän Karjala, luonnonpuisto, kansallispuisto, metsäekosysteemi, suoekosysteemi, kasvillisuus, putkilokasvit, jäkälät, sammalet, maksasammalet, hyönteiset, geologia, geomorfologia, uhanalaiset ja harvinaiset lajit	
Julkaisusarjan nimi ja numero	Alueelliset ympäristöjulkaisut 158	
Julkaisun teema		
Projektihankkeen nimi ja projektinumero	"Kuusamon vanhojen metsien suojelu", EU:n LIFE Nature -projekti (B4-3200/96/543)	
Rahoittaja/ toimeksiantaja	EU/LIFE Nature, Pohjois-Pohjanmaan ympäristökeskus	
Projektiryhmään kuuluvat organisaatiot		
	ISSN 1238-8610	ISBN 952-11-0700-6
	Sivuja 206	Kieli Suomi
	Luottamuksellisuus Julkinen	Hinta 150 mk
Julkaisun myynti/ jakaja	Pohjois-Pohjanmaan ympäristökeskus puh. (08) 315 8300 faksi (08) 315 8305	Oy Edita Ab puh. (09) 566 0266 faksi (09) 566 0380
Julkaisun kustantaja	EU/LIFE Nature, Pohjois-Pohjanmaan ympäristökeskus	
Painopaikka ja -aika	Multiprint, Oulu 2000	

Presentationsblad

Utgivare	Norra Österbottens miljöcentral	Datum Mars 2000
Författare	Raimo Heikkilä, Hanna Heikkilä, Aleksei Polevoi & Evgeni Yakovlev (red.)	
Publikationens titel	Biodiversity of old-growth forests and its conservation in northwestern Russia	
Publikationens delar/ andra publikationer inom samma projekt		
Sammandrag	De fem artiklarna i den här publikationen handlar om den biologiska mångfalden och dess skyddsbehov på gränsregionen i ryska Karelen vid Finlands gräns. Undersökningarna handlar om områdets geologi och geomorfologi, kärlväxt, lav, moss, levermoss och insektfauna samt mosaik i skogs- och mossekosystemet. På området upphittades flera hotade och nya djur- och växtarter för Karelen. Vissa växtsamhällen var tidigare ökända i Karelen. På grund av undersökningarna har man gjort förslag för att utvidga naturskyddsområdet i Kostamus, gränsa den förslagna Kalevala-nationalparken och grunda nya små naturskyddsområden. Undersökningarna visar att hittilsvarande naturskyddsområden och naturskyddsplaner är inte tillräckliga för att bevara den biologiska mångfalden på områden.	
Nyckelord	biologisk mångfald, naturskydd, gammelskogar, ryska Karelen, naturskyddsområd, nationalpark, skogsekosystem, mossekosystem, vegetation, kärlväxt, lav, moss, levermoss, insektfauna, geologi, geomorfologi, hotade och rara arter	
Publikationsserie och nummer	Regionala miljöpublikationer 158	
Publikationens tema		
Projektets namn och nummer	"Protection of old-growth forests in Kuusamo area", EU LIFE Nature-projekt (B4-3200/96/543)	
Finansiär/ uppdragsgivare	EU/LIFE Nature, Norra Österbottens miljöcentral	
Organisationer i projektgruppen		
	ISSN 1238-8610	ISBN 952-11-0700-6
	Sidantal 206	Språk Finsk
	Offentlighet Offentlig	Pris 150 FIM
Beställningar/ distribution	Norra Österbottens miljöcentral tel. (08) 315 8300, fax. (08) 315 8305	Oy Edita Ab tel. (09) 566 0266, fax. (09) 566 0380
Förläggare	EU/LIFE Nature, Norra Österbottens miljöcentral	
Tryckeri/ tryckningsort och -år	Multiprint, Oulu 2000	

Biodiversity of old-growth forests and its conservation in northwestern Russia

The five articles of this publication deal with the biodiversity of northwestern Karelian Republic along the Finnish boundary and needs for its conservation. The studies cover geology and geomorphology of the area, mosaic forest and mire ecosystems as well as flora of vascular plants, lichens, bryophytes and hepatics, and fauna of insects. Numerous threatened and new species for Karelia were found, and also some plant communities were not described earlier. On the basis of the studies, proposals for the extension of Kostamus strict nature reserve, boundaries of the proposed Kalevala national park as well as establishing some new small nature reserves were made. The results show that present nature reserves and conservation plans do not adequately guarantee the preservation of biodiversity in the region.

ISBN 952-11-0700-6

ISSN 1238-8610

For sale at:
North Ostrobothnia Regional Environmet Centre
Phone +358 8 315 8300, fax +358 8 315 8305
Edita Ltd
Phone +358 9 566 0266, fax +358 9 566 0380

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